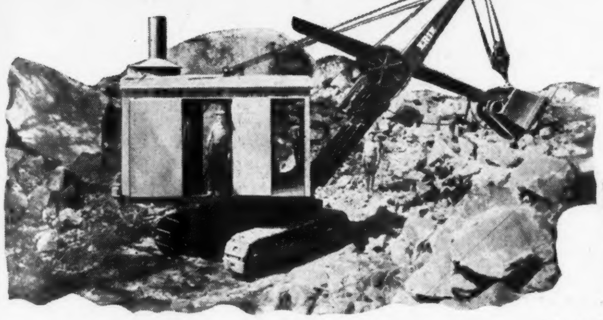
Pit and Quarry

SAND-GRAVEL-STONE CEMENT-LIME-GYPSUM



Record-breaking Sales of ERIES

Every month of 1926 ran ahead of every corresponding month of any previous year! Ahead of the big war years— ahead of 1923, the big construction boom year.

More than 4,200 ERIES in service—far more revolving shovels and cranes than any other manufacturer has produced.

The buyers of shovels and cranes want BIG PRODUCTION, and the reliability that means *steady* production.

ERIES are the

Largest Sellers

because they are the

Biggest Producers

The efficiency of the Steam ERIE is reflected in the record-breaking sales during 1926.

Confidence in ERIE Steam Shovels and Cranes has been due largely to the sound design. Year after year we have made *improvements, but no radical changes.*

The 1 cu. yd. ERIE B-2 Steam "Dreadnaught" is a shovel for heavy work and plenty of it— but as easy to move as a ¾-yd. machine.

Built with an even wider margin of *reliability* than past Steam ERIES, which have saved their owners two-thirds of upkeep expense, as shown by hundreds of actual cost records.

Gas+Air ERIE is its own best salesman—

It's only two years since the first Gas+Air ERIES went into field service— only one year since quantity production began— and

REPEAT ORDERS now equal 38% of the number of first machines!

There are now 2, 3 or more Gas+Air ERIES owned by many successful producers.

This is the BIG PRODUCTION Gas Shovel— it's *all direct drive.* "Crowds" and "swings" by direct-connected air engines— digs much more material than a friction drive shovel.

Write us for production records made by Gas+Air ERIES— *buy this machine on its actual performance!*

ERIE STEAM SHOVEL CO., Erie, Pa., U. S. A.

GAS+AIR ERIE and Steam DREADNAUGHT

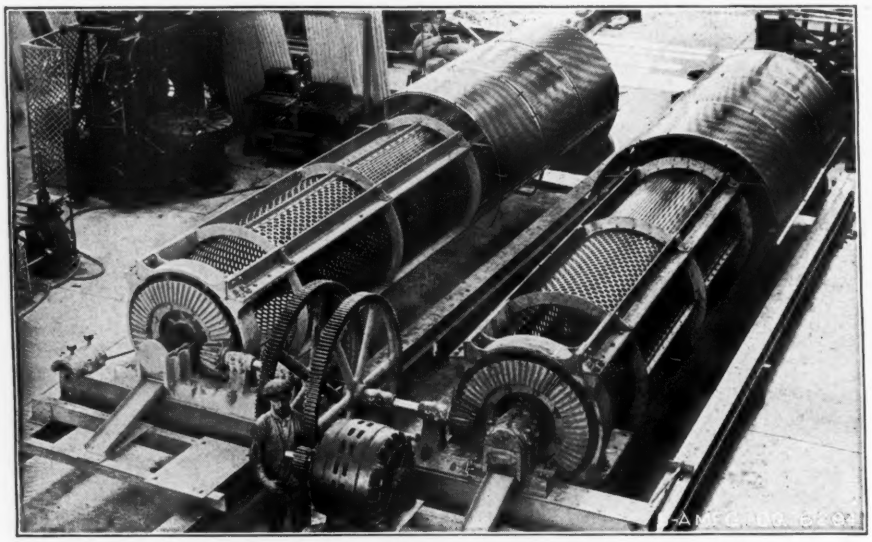
SHOVELS, CRANES, DRAGLINES, TRENCH HOES, ETC.

Branch Offices: Boston, New York, Philadelphia, Atlanta, Pittsburgh, Chicago.

Representatives throughout the U. S. A.

Vol. XIII, No. 10 FEBRUARY 16, 1927 Circulation, 7,000

SCREENS



Two of a set of four 48-inch diameter by 24 feet long screens are in the service of the Santa Catalina Island Co.

When it comes to the designing and building of revolving screens, S-A Engineers are ready to handle the job. Every screen should be specified by an expert Engineer who is familiar with the conditions of operation. Proper design and rugged construction must be part of every separation equipment to assure the proper operation.

S-A Engineers build all classes of screens—rotating, shaking, reciprocating, gravity, and vibrating.

STEPHENS-ADAMSON MFG. CO.
AURORA, ILLINOIS, AND LOS ANGELES

STEPHENS-ADAMSON

Pit and Quarry

Published Every Other Wednesday for Producers and Manufacturers of Sand Gravel, Stone, Cement, Gypsum, Lime and Other Non-Metallic Minerals.

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Vol. 13 — CHICAGO, ILL., FEBRUARY 16, 1927 — No. 10

FEATURE CONTENTS

Pass It On

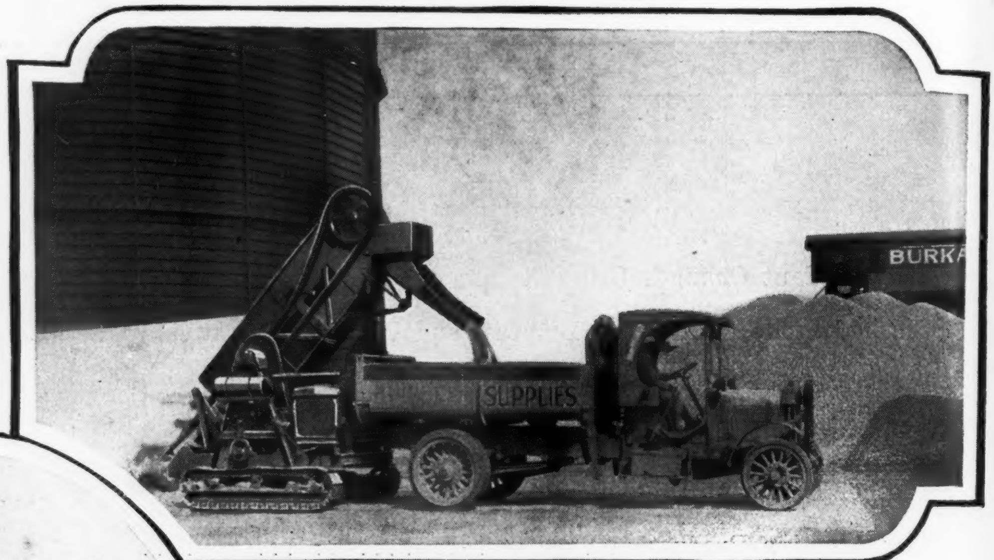
Next Issue March, 2, 1927

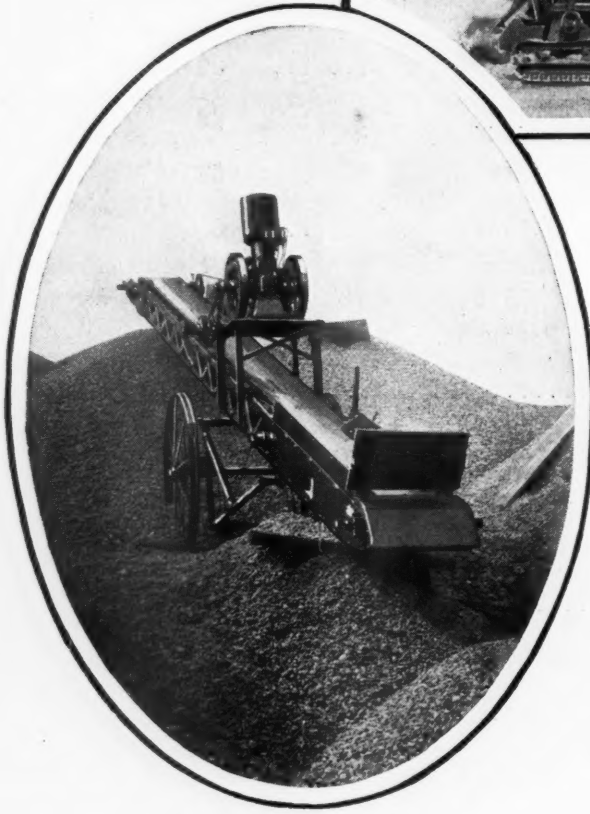
COMPLETE SERVICE PUBLISHING COMPANY
538 S. Clark St., Chicago, Ill.
Publishers of
PIT AND QUARRY and *Pit and Quarry* HANDBOOK

Murtland's Haiss Equipment is a paying investment

At the right is Mr. Murtland's Model 25 Haiss Creeper Loader putting up a load of sand.

Below is the Haiss Troughing Belt Conveyor used both for building high stockpiles and for loading trucks.





Haiss Portable Belt Conveyors are described in Catalog 925—ask for a copy..

John Murtland, of Atlantic City, knows how to spend his money to advantage. The two types of Haiss machines have proven profitable investments.

Murtland's **Haiss Portable Conveyor** handles a-ton-a-minute in loading trucks and has many other yard uses. Its ball bearing belt rollers and other features of good design make it a high-economy unit to own.

The Haiss **Creeper Bucket Loader** works faster and does away with all hand shoveling. It puts up a full load of sand or gravel on a **5-ton truck in three minutes.** The broad Creeper treads need no planking even in muddy weather. And the slow-speed crowding drive works the machine back into the pile automatically.

Whether your yard is large or small, one or both of these Haiss Loaders will be as profitable an investment as they are to John Murtland.

Haiss Loader parts wear in time but your upkeep cost is the replacement of worn-out-in-long-service parts, not in breakages. A big, powerful Haiss Loader is a cheap machine to own.

Let Catalog 523 explain its fine points to you

Manufacturer of
THE GEORGE
--Truck and-- Wagon Loaders
Portable Belt Conveyors

HAISS

142nd Street and Rider Avenue, New York
Representatives Throughout the World
Millars Timber & Trading Co., London, British Representative.
Cable Address "Coalhoist" New York—"Western Union 5 Letter Edition" Code

Established 1892
MFG. CO. INC
Clam Shell --Buckets--
Mat'l Handling Equipment.

Pit and Quarry

Vol. 13 CHICAGO, ILL., FEBRUARY 16, 1927 No. 10

MORE ABOUT FOREMAN SELECTION

IT HAS been the experience of practically every man in supervisory positions to have an otherwise good employee spoil himself and his chances for further advancement by contracting the "big head" over some minor promotion or the simple addition of responsibility or authority. Men of mediocre minds feel that to qualify for a foremanship they must be drivers. And there is a great difference between a driver and a leader.

The leader is a man who is human and treats all others as though they might also be human. He is the man who briefly and clearly tells what he wants done, shows or demonstrates what is not understood, and gets results. The driver is the "do this" and "do that" sort of an individual. He explains nothing, then gets angry if the work is improperly done. Never supplementing instructions with explanations, he is wont to think of his men as "damned dumbbells" because they cannot read his mind or properly guess at his methods. The driver is the man who believes in the doctrine of keeping everyone "scared for his job," not infrequently discharging a man for the purpose of further instilling this fear. The driver gets results after a sort—but it is a poor sort, for invariably there develops a row in the department that affects the entire organization. There is only one thing to do with these two men: Promote the leader; demote the driver.

The fact that a man is a driver is no indication that he has courage. Courage is a basic essential to good foremanship. Without it no one can hope to get results or be a successful leader. But courage is never loud-mouthed bossiness. Every foreman must have the courage to tell his men what to and what not to do. The difference in the results usually lies in the manner of telling. Courage and a human heart is the best possible combination, while the "courage" of blind driving force will not only break the foreman but probably the entire department.

Among our acquaintance there is a man that is liked and respected by each of his nine foremen and 188 men. This superintendent has ever kept before him this fundamental principle: Human nature is imperfect. He never expects any man to do work in just the manner he himself would do it. He knows no foreman can ever measure up to the high standards he would like to see in men. He is honest, truthful, courageous, conscientious, and endowed with the spirit of humanity tempered with common sense. Many of his foremen affectionately refer to him as the "man with uncommon sense," and not a foreman does he have who fails to, at least unconsciously, follow in his footsteps. The firm for whom this superintendent works is nationally known among engineering and manufacturing concerns and has large plants in various parts of the country. The labor turnover in the plant this man superintends is lower by 30 per cent than in any other of this company's factories. Therein lies the value of good foremanship.

EXECUTIVES OFTEN AT FAULT

THERE is a story going the rounds just now of a Boston merchant who, finding his commercial success rather more fancied than real, asked for frank, confidential opinions from his department heads, as to the real cause of the low dividend showing. Among those asked for an opinion was one who took the request literally and boldly said: "Do you want me to say what I think, even if it is not entirely complimentary?"

"Certainly, speak your mind. I want to get at the facts."

"In my judgment, then," said the employee, "the big thing that is wrong with this store is you. You—and the attitude of the employers toward the employees. As things are now, every night when the store closes, there is turned loose a crowd of knockers who go home and kick about something or other and who do not hesitate to talk among their friends and acquaintances in a way that does the store no good. They are not boosting your store when they are away from it, and they are not working energetically and wholeheartedly for its success when they are in it.

"Your selling force is the store as far as the customer is concerned. The public does business with employees, not with you. If the salespeople are not interested in the success of the store, and they aren't, they are not going to exert themselves any more than just enough to hold their jobs and draw their pay.

"If you will take a more friendly attitude, pay a little more attention to your people, pay more liberal salaries, you will get returns that will be worth while in the way of better spirit, harder work and larger sales. And you will find a better class of people applying to you for positions, and the better class staying with you, instead of only those staying who can find no other place to go."

This was a bitter pill for the employer to swallow, but he took it with a grace that bespoke his stamina. Indeed, he even asked further questions, delved into the matter until he got at its bottom, found the opinion to be fully sound, then took immediate steps for correction.

With so much written and lectured now-a-days on, to, and for the employee, and with so many carloads of material available the executive on how to do this, and how to do that, we sometimes wonder if a bold, frank discussion of the common failings in all executives would not be medicine for commercial and industrial health. Are discontented and dissatisfied employees—is labor turnover, lack of interest, tardiness, absenteeism, limited production, and all other similar problems, due entirely to physical conditions of the plant or to the vagaries of the employed? Are they not, in part, due to the negative personalities or sheer inefficiencies of the controlling executives? It is doubtless true that every executive possesses qualities of leadership else they would not long remain in executive positions. But is it not equally apparent that nearly every executive must be lacking in some regard when problems of comparatively simple solution remain unsolved?

To visit a hospital every year for an annual inspection and physical overhauling keeps one in the best possible physical condition. To periodically check up one's own self, or to consult those who are most likely to be brutally frank, will go far toward bettering the mental condition and over-all efficiency of any one. Searching self-analysis is a good thing at all times.

MEDICAL EXAMINATION FOR EXECUTIVES

FATIGUE that comes with mental and nervous strain is far more wearing than the fatigue that comes through muscular exertion. Pressure of duties, the burden of responsibilities, the fear of failure, the strain of important decisions, worry and interruption, all go to make up the executive's day. It is such that contribute also, to mental fatigue and nervous tension which, if permitted to constantly enlarge and remain uncorrected, will greatly impair the executive's efficiency.

Recognizing this, one large manufacturer in Pennsylvania employed a consulting physician to care for the health of his immediate subordinates. In the employment of this practitioner the manufacturer said: "Within reason, you have no limitations. You will have to care for only the executives—general manager, department heads, superintendents, and like men. As you might know, a sick executive is worse than none at all. It is your job to keep my men well, physically at least, mentally, if possible."

After the preliminary physical examination and study of individual diets, one of the first things this physician ordered was an extension in vacation time from the usual two weeks to three weeks. In addition to this extension, he insisted each man take a three-day leave of absence from his desk every four months, thus making a total of four weeks vacation each year. The physician saw to it that these vacations brought a complete change of scene, environment and activity. This work, supplemented with some consultation advice on diet and exercise, resulted in reducing the absentee records to such an extent that in spite of the doubled vacation time and the shorter hours imposed, the total time worked per year by the group was considerably in excess of what it had ever been. Naturally, there was a noticeable increase in efficiency and enthusiasm, those factors far more than compensating for the expense involved.

TREND IN STRIKES IS DOWNWARD

PERHAPS no more graphic illustration of the collosal waste incident to industrial strikes will ever be afforded than that of last year's British coal dispute. In the 29 weeks duration of this strike 1,100,000 men were involved, a waste in idleness of 140.000,000 days caused, and a loss of 1,775 millions of dollars sustained by the miners and operators. Nor do even these incomprehensible totals take into consideration the indirect costs of the strike, such as, for instance, the throwing out of employment more than 550,000 men in other trades.

Throughout the progressive world discontent in industry was stimulated by the war. The heterogeneous contacts of those hectic 52 months gave the worker a deep-seated impatience with the established order of things, which resulted, in Great Britain, in mounting the loss of time by strikes from 11,500,000 days in 1913 to an average of 40,000,000 days a year for the post war period of 1919 to 1926; while in the United States, that of increasing the number of industrial disputes from a scant 650 in 1913 to 2,665 in 1919.

With the crash of post war prosperity in 1921, however, untold thousands came to the realization that a healthy industry depended upon good labor as well as good management, and that both must be fairly compensated.

RADICAL PLANT CHANGES BRINGS RESULTS TO OHIO HYDRATE AND SUPPLY COMPANY

By Frank E. Coombs
Traffic Manager, Ohio Hydrate and Supply Company

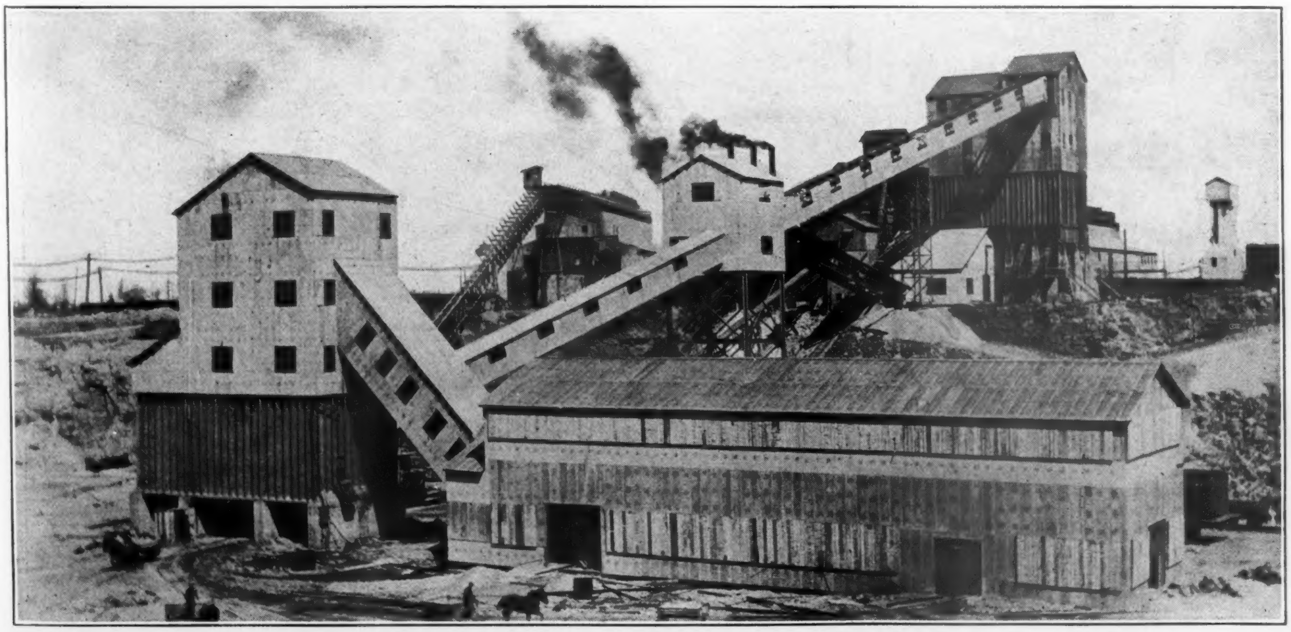
OHIO produces more than one-half of the hydrated lime in the United States. The "Woodville District" which includes the territory in and around Woodville, Ohio, is center of the lime industry of Ohio and is generally referred to as "The Finishing Lime Center of the World." During the past year or two extensive and radical changes have been made by the plants in this territory.

The Ohio Hydrate and Supply Company are at present making the most extensive and radical improvements. A new twelve kiln addition has just been completed increasing the total to thirty-six kilns with a daily output of more than six hundred tons of hydrated finishing lime. The new kilns have a twelve and one-half foot steel shell and extend thirty-one feet above the firing floor. A straight kiln section four feet in length before the cone cooler is attached extends below the firing floor. This construction insures a larger cooling area than formerly. Harbison Walker fire brick are used throughout for lining the kilns. All kilns are equipped with McGinty slaking grates under which steam is suppled for moisture and induced draft.

A very systematic method is employed in firing the kilns which are under fire day and night for a period of eight to twelve months during the year, depending upon the life of the fire brick lining. The furnaces are charged every thirty minutes and the lime is drawn from the kilns every four hours. The fires are thoroughly cleaned every twenty-four hours. The stone dust is burned in furnaces on opposite sides of the shaft through which the stone passes. The gases from the fuel tempered with steam are drawn up through port holes into the heated stone where they drive off or free the carbon dioxide. This method of flame burning results in a pure white lime free from all ashes and from all taint of coal smoke. The raw limestone must be heated from 1800 to 2000 degree Fahrenheit to drive off the carbon dioxide so the highest grade of coal with the least amount of sulphur and ash is used. An elevated track, under which is installed a pan conveyor and two drag conveyors permits the delivery of coal to either side of the kilns. The coal is spouted directly to the firing floor.

At each period of four hours, or drawing period, the lime is drawn from the kilns into Easton gable bottom cars and conveyed by means of Plymouth gasoline locomotives to an incline. The lime is hoisted up the incline and dumped into a four hundred and fifty ton cooling bin. This bin is divided into five compartments which permits the lime being cooled in four of the compartments while drawing lime from the fifth. The cooled lime is then discharged to a slow moving pan conveyor, or picking table, at which four men are working day and night inspecting and picking the lime. These workmen remove all overburnt and underburnt lime and any substance foreign to lime.

The chemical lime plant has a capacity of ap-



General View of the Ohio Hydrate and Supply Company Plant.

Excellent View of the Quarry Showing Fifty Foot Smooth Face.

proximately two hundred tons of ground burnt lime per day. The lime is hand picked over a picking table before grinding and screening. The Ceramic Industry has shown an extraordinary interest in the use of the various dolomite lime products manufactured in the Woodville District during the past several years. Chemical superfine hydrated lime is made from pure dolomite ground lime by passing the crude hydrate through Raymond air separators.

The inspected lime is crushed to a fineness of from 3/8 inch to dust by a Williams hammer mill. The lime from the Williams mills is conveyed to to another large storage bin. From this storage bin, the lime is handled by Schaeffer poidometers which accurately and automatically weigh a predetermined proportion amount of water and lime. The poidometers discharge into the Schaeffer continuous hydrators. As the lime passes into the hydrators, it is constantly agitated by huge plows while being subjected to a steam bath for thirty minutes. The lime enters the hydrators at the top and passes through eight levels in the process of hydration. The use of steam as the lime passes through the hydrators produces a thoroughly hydrated product which will not pit or pop.

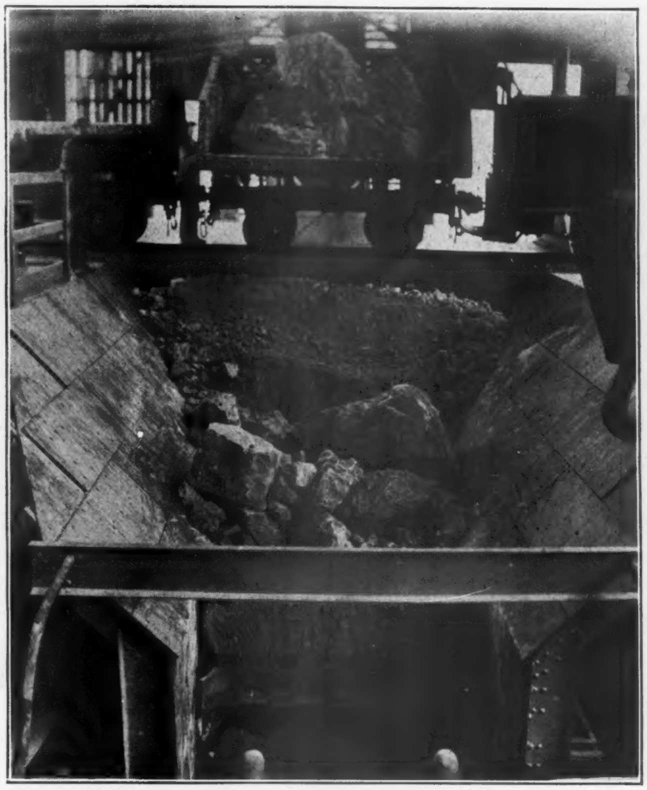
The crude hydrate is elevated and conveyed over aerators designed by the Ohio Hydrate and Supply Company. The heat of the lime drives off the free moisture and the lime is cooled so that it can be

View Showing Crushing Plant in Quarry and Incline.

completely and thoroughly separated. The lime, after leaving the aerators, is passed through Bonnot, Raymond beaters or Raymond roller mills according to the requirements of the trade. The finished product from the various mills is elevated to finishing lime, superfine hydrated lime and general purpose bins. A battery of four Bates valve baggers, with a capacity of twenty-four bags per minute or 28,800 bags per day of twenty-four hours, pack the lime. Before loading, all cars are carefully inspected, cleaned and repaired to insure protection of material in transit from the elements of weather. Corrugated box board is used in lining the cars in order to keep the bags clean and free from all foreign matter that may be between the linings of the car. This box board also serves as a cushion and tends to prevent breakage in transit. Only competent American men are employed with an experienced foreman in charge in the loading department.

The most radical change that the Ohio Hydrate and Supply Company has made and one which has brought excellent results in the operation from the raw stone to the finished product was the installation of the crushing plant in the quarry. The new crushing plant does away with all hand labor and thereby eliminating the ever changing personnel factor. In the quarry Marion electric shovels and Plymouth gasoline locomotives handle and convey the crushed rock. This equipment does away with smoke, ashes, boiler trouble, etc.

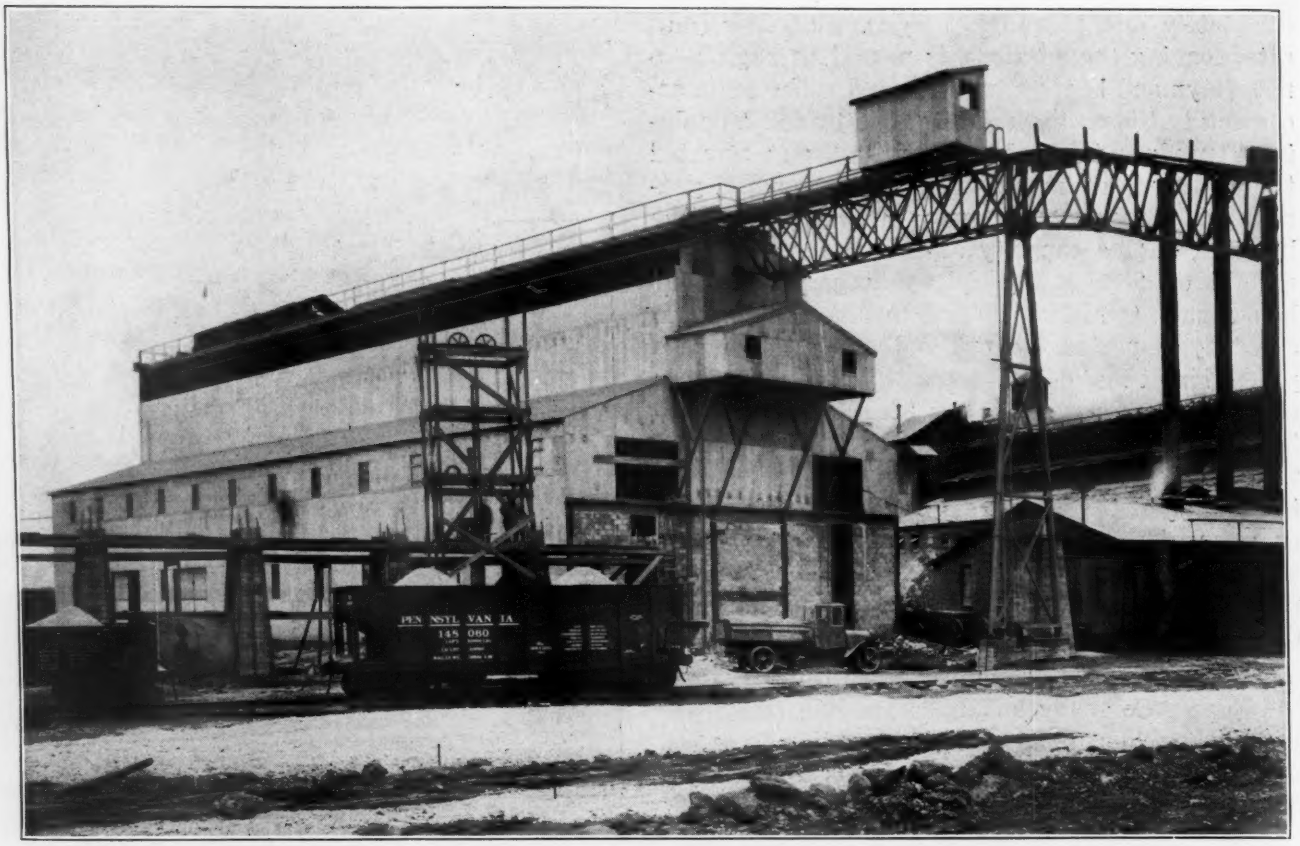
A smooth fifty foot quarry face is maintained at all times. The overburden is removed by means



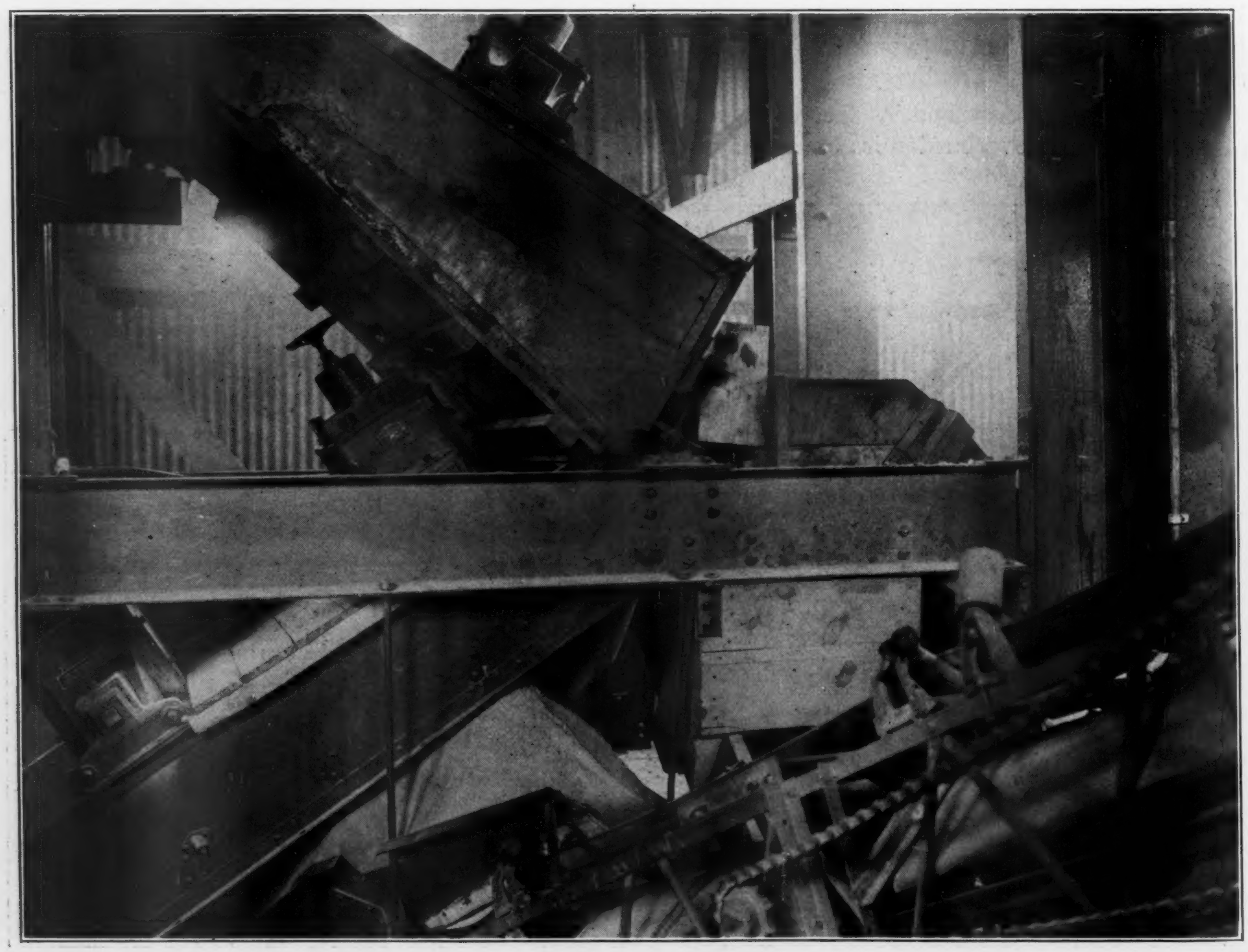
Discharge to Initial Crusher.

of a steam shovel. The overburden is used for railroad fill. The stone is then scraped or swept before drilling. The dust from the quarry is, therefore, 99 per cent plus pure. Two Loomis well drills are operating on the ledge of the quarry, sinking their holes at uniform distance in depth around the entire quarry face. This stone is then blasted

Typical Quarry Train for Handling Stone to Crusher.



The Kiln Buliding with Incline Over Top.



One of the Vibrating Screens.

down into a huge windrow, so to speak, by means of enormous charges of dynamite. A three and one-half yard model 92 Marion electric shovel loads the stone into nine-yard Easton side dump cars. Two sixteen-ton Plymouth gasoline locomotives, operating on a standard gauge track, convey the trainloads of stone to the large crushing building, which is situated on the level of the quarry bottom. The stone is dumped by means of Curtis air hoists onto a Traylor apron feeder, which delivers the stone to a sixty-inch by eighty-four inch Traylor Bull Dog jaw crusher. The crushing jaw measures seven feet in width by eighteen feet in height and is operated by means of a three hundred and fifty horse power motor. The driving units of the crusher, which gives the jaw its momentum, consists of a huge shaft, 16 feet driving pulley, 30 inch face and a 12 feet flywheel. This crusher has a capacity of 500 tons per hour.

The crusher delivers its stone to a 48 inch Link-Belt pan conveyor, which carries the material to another building, where a preliminary separation is made. This pan conveyor is 137 feet on centers and is driven by a 100 horse power motor, back geared, and equipped with Link-Belt Silent Chain Drive. From the pan conveyor the stone is discharged to a Bar Grizzly, which also acts as a feeder to the Robins "Cataract" Grizzly or screen. The kiln stone, 4 inch by 9 inch, is deposited into two bins on either side of the building from which it is transported by gable dump cars to the kilns. The Commercial stone, 5 inch by dust, which passes through the openings in the bars in the Robins screen, is deposited in a large central bin. The material destined for the commercial plant, size 5 inch to dust, is fed onto a 30-inch Robins belt conveyor on 371 feet centers and is carried to the top of the screening house, which stands near to the edge of the quarry at ground level. The feed on to the belt at this and other points is by means of Robins shaking feeders. The belt conveyor, as are other conveyors at the plant, is entirely enclosed in a structure of steel and corrugated galvanized iron, large and well lighted and with an easy walkway its entire length. At a midway point is a junction house, where the material from the recrushing mill comes up on an auxiliary belt and is returned to the main conveyor.

At the top of the screening house the material falls from the belt conveyor on another Robins rotary grizzly with five 8-inch rolls, and from this to a Robins "Bronco" shaking screen. Then follows four Hum-mer vibrating screens in series, one of them a double surface machine, making two separations. Ten sizes of commercial stone are made in all and are sold for a variety of uses, including the chemical trades, concrete products, agricultural purposes, highway and general concrete work, steel fluxing, etc. The bins are all of steel construction and the commercial bins have a capacity of 30 cars. Four loading tracks have access to them and in addition, there is a truck road leading to the bins without interference from the railroad tracks. A recrushing building is provided

Close-up of the Discharge Side of the Crushing Plant.

for taking care of peak demand, or for taking from the bins any sizes which are not moving and re-crushing them to sizes immediately marketable. This building is equipped with a No. 7½ Austin crusher and a 36-inch Symons disk. The product of these crushers is carried by a 20 inch belt conveyor to the junction house, before mentioned, and there transferred to the main conveyor.

The lime and crushing plants have both grown out of the experience of men in the organization. Three, who have cooperated most closely on their design, have been E. G. Baker, late president, whose death occurred on April 3, 1926; Fred Witmer, secretary and sales manager of the company since its inception and now promoted to the presidency since the death of Mr. Baker; and J. R. Reaver, the superintendent. Mr. Witmer, in addition to his recent election to the presidency of his company, has also been chosen to head the Finishing Lime Manufacturers' Association of Ohio. The remaining personnel of the Ohio Hydrate and Supply Company includes E. H. Mauntler, secretary-treasurer; Otis Bittinger, general manager; L. E. Fishack, sales manager; Frank E. Coombs, traffic manager; and Russell L. Hardy, chemist.

The points of most interest to the Building Supply Dealers are quality and service. The office of the company is located within one-half mile of the plant, thereby enabling the officers of the company to keep in close contact with any and all conditions pertaining to the plant or business. A well equipped chemical laboratory is located in the main office with a physical laboratory at the plant and all kinds of tests pertaining to their products are being made constantly. This control of the product does not end in the laboratories but goes into the plant itself, where technical supervision regulates the process of manufacture at all times. The condition of the stone in the quarry, firing the kilns, inspection and hydration of the lime are carefully watched.

The company spares no expense when it comes to shipping their lime. If any amount of the lime in the plant does not come up to their requirements, that tonnage is immediately diverted into channels that would permit of its being used.

The capacity of the plant for production enables the Ohio Hydrate and Supply Company to ship over 95 per cent of the orders received the same day. Each order is handled by a company executive. Each shipment is checked by the Traffic Department to insure the lowest rate and the quickest route. This department constantly checks the time consumed in transit so as to speed up the service, watches changes in rates and tries in every way to give each of their customers the prompt service to which they are entitled. With the installation of its new equipment and with its smooth working organization, the Ohio Hydrate and Supply Company prides itself on the service it is enabled to give each of their customers. The company recently purchased two additional tracts of land, one of which is now used as an aviation field by the United States Air Mail service. When aeroplanes are used by their customers a safe landing place close to the plant has been insured. The officers of the company have gained the confidence of their employees largely because they constantly look ahead.

Lime Picking Table. All Lime Is Hand Picked Before Grinding.

CRUSHED STONE FOR SEWAGE DISPOSAL AND WATER PURIFICATION WORK

By William E. Stanley,
Pearse, Greeley and Hansen*

THE quantities of crushed stone required for the construction of sewage disposal and water purification plants during the past have been a mere drop in the bucket compared to the quantities of material required for other purposes. The quantities which will be required in the future will be comparatively small in contrast to the highway demand, for example. However, sewage disposal and water purification plants will be built in increasingly greater numbers and larger installations during the next few years with a greater demand for crushed stone, particularly for use as filter media in sewage trickling filters.

Crushed stone used in sewage disposal and water purification works falls under two divisions, as follows:

(a) Aggregates for concrete masonry work in the construction of various structures which make up a sewage disposal or a water purification plant.

(b) Filter media in the filtration elements of a sewage disposal or water purification plant.

The use of crushed stone as a concrete aggregate in the construction of the structures of a sewage disposal or a water purification plant is little or no different from the use of crushed stone as aggregates in any other concrete construction work, such as highway pavements, concrete bridges and so on. It is to the use of crushed stone as filter media that I wish particularly to call your attention today.

The particular elements of sewage treatment works or water purification plants in which crushed stone is used as a part of the filter media, are as follows:

(a) Sewage treatment plants
- (1) Trickling or sprinkling filters.
- (2) Contact filters.
- (3) Intermittent sand filters.
- (4) Sludge filters.

In the case of the first two types of filters, crushed stone forms the principal part of the filter bed. In the case of the second two types of filters, namely, the intermittent sand filter and the sludge filter, crushed stone is often used as a supporting element and as a means of draining a bed of sand which is the principal filter media.

(b) Water purification plants
- (1) Rapid sand filters.
- (2) Slow sand filters.

In the case of water purification plants the principal filter media is usually a bed of sand with properly graded crushed stone or gravel being used as a support for the sand bed.

The use of crushed stone as a coarse grained filter media in sewage disposal work is a field which is rapidly developing and which will require increasingly large quantities of especially selected and graded material during the next few years. The fine grained sewage filters and water purification works will not require appreciable quantities nor as carefully selected materials. Because of the greater demand for high grade material for use as coarse grained filter media in sewage disposal works, I will confine my remarks largely to this phase of the subject.

Crushed stone as coarse grained filter media in sewage disposal work may be used either in trickling filter beds or contact filter beds. During the past years a considerable number of contact filters have been built. However, at the present time the tendency seems to be toward other methods of sewage treatment. In connection with these methods, trickling filters have become one of the standard elements of a large number of sewage treatment plants.

Sewage Disposal Works

Sewage disposal works may include structures wherein the sewage is only partially treated or more extended structures wherein the sewage is more completely treated. The partial treatment works comprise coarse screens, settling tanks, sludge digestion tanks, sludge beds and perhaps a chlorination plant. The works for more complete treatment include the above mentioned elements for partial clarification of the sewage, and then in addition other elements in which the effluent from the settling tanks is further purified by oxidation of the organic matter in solution. There are two general types of plants for performing this latter function: The activated sludge plant and the trickling filter plant. It is in the latter type of plants that large quantities of crushed stone are required for filter media.

Trickling filters consist of beds especially selected and graded filter media. These beds cover surface areas ranging from a few square feet in some of the smaller units to upwards of thirty acres at Baltimore, and range in depth from five to ten feet. The filter media may consist of crushed stone, crushed gravel, crushed slag or an equivalent material. This bed of filter media rests on an especially constructed underdrain system.

*Presented before the Tenth Annual Convention of the National Crushed Stone Association, January 17, 1927.

Sewage is distributed over the surface of the filter bed in the form of a spray from nozzles or drippings from troughs so that the sewage covers the whole surface as uniformly as possible. The sewage trickles down through the bed of stone and the dissolved organic material is oxidized into staple mineral products through the agency of large numbers of bacteria and other microscopic plant and animal life which grow on the surface of the filter in the form of a jelly-like film. The sewage reaching the bottom of the filter is collected together by the underdrain system into an outlet channel, thence to final settling tanks and then to disposal in a river or other body of water. I have a number of slides which illustrate the construction of typical trickling filter plants.

Table I

NUMBER OF INSTALLATIONS OF SEWAGE FILTER PLANTS WITH APPROXIMATE POPULATION DATA

Results of Recent Census by Questionnaire Sent to State Sanitary Engineers

	All Plants Reported		Plants Reported With Detailed Information	
State	Number	Approximate Population	Number	Approximate Population
I—States East of the Mississippi River				
Alabama	1	80,000	1	80,000
Connecticut	1	6,000	1	6,000
Georgia	4	385,000	4	385,000
Illinois	31	188,000	7	133,000
Indiana	5	30,000	...	......
Kentucky	2	53,000	2	53,000
Maryland	7	709,000	7	709,000
Massachusetts	4	304,000	3	291,000
Michigan	7	75,000	7	75,000
Mississippi	3	17,000	3	17,000
New Jersey	18	103,600	18	103,600
New York	6	108,000	6	108,000
Ohio	24	563,000	24	563,000
Pennsylvania	14	76,000	14	76,000
Rhode Island	1	14,000	1	14,000
Tennessee	4	14,500	4	14,500
Virginia	6	12,000	4	12,000
West Virginia	2	6,400	2	6,400
Wisconsin	2	48,500	2	48,500
Totals East of the Mississippi River	142	2,793,000	110	2,695,000
II—States West of the Mississippi River				
Arizona	2	13,700	2	13,700
California	14	49,700	14	49,700
Colorado	4	20,500	4	20,500
Iowa	38	94,300	16	59,500
Kansas	33	121,200	24	105,000
Minnesota	33	51,700	6	48,400
Missouri	17	115,700	11	105,400
South Dakota	9	54,700	3	25,000
Texas	122	718,000	13	209,000
Totals West of the Mississippi River	246	1,239,500	93	636,200
Totals East of the Mississippi River	142	2,793,000	110	2,695,000
Grand Total	388	4,032,500	203	3,331,200

Qualities for Filter Media

Experience in a large number of operating plants and special testing station plants has indicated that the filter media for best results in a trickling filter must have certain physical qualities, the principal of which are as follows:

(1) The material must be of such size as to provide ample bacterial surfaces, thereby affecting purification and at the same time it must not clog.

(2) The material must be of proper physical quality so as not to disintegrate under exposure to weather and to the action of the sewage.

(3) The surfaces of the filter grains must be neither too smooth nor too rough. It is necessary that the surfaces have a certain degree of roughness in order that the bacterial film may adhere to the stone. On the other hand at times it is necessary that portions of this bacterial film slough off and should the surfaces of the filter grains be too rough the sloughing of the bacterial film will be retarded, tending to clogging of the filter and thus a reduction in the efficiency of the filter bed.

Size of Filter Media

The size of stone used as filter media in various existing installations varies between rather wide limits. For example in filter beds built at Worcester, Massachusetts, comprising fourteen acres ten feet deep, crushed granite and trap rock were used ranging in size from one inch to three inches, while at Madison, Wisconsin, crushed limestone ranging from one-quarter inch to three-quarter inch in size has been used for the top eighteen inches of filter bed since 1917 with very good success. In general experience with existing plants and particularly the results from special testing stations indicate that the size for best results ranged from one inch to two and one-half inches in diameter for the upper section of a filter bed. It is rather important with respect to size of material that there be no large amount of small material and that the greater part of the material be of a uniform size. At Akron, Ohio, trickling filters are in the process of construction comprising fourteen acres of beds ten feet deep, requiring a total of 223,000 cubic yards of material. Specifications covering the selection of the material for this installation were very carefully worked up. The specifications with respect to size of material are as follows:

"The filtering material shall be of such size that as loaded on the cars not more than five (5) per cent by weight of any carload will pass through a screen having round holes one (1) inch in diameter and not more than one (1) per cent by weight of any carload will fail to pass through a screen having round holes two and one-half (2½) inches in diameter. If the filtering material is not to be rescreened by the city at the point of delivery, screen tests will be made on samples collected according to Standard Methods of Sampling Stone for use as Highway Material, Serial Designation D75-22, of the American Society for Testing Materials. The stone may be sampled either prior to shipment or after delivery."

Physical Characteristics

The question of what the proper physical characteristics are which make for good material for trickling filter media is perhaps the most uncertain, and at the same time the most important item bearing on the proper selection of material for use in sewage filters.

Physical characteristics which make for durability in operation are important, particularly in the central section of the country where limestone is a large source of filtering material. In these sections of the country where hard material, such as granite, trap rock and quartsite are available, the item of proper determinations of durability is less important as it is relatively easy to obtain samples of these materials which will not deteriorate due to freezing or to the action of sewage on the stone.

A recent census of existing coarse grained sewage filters located a total of 388 plants scattered from the Atlantic to the Pacific Coast. Of these 128 were trickling filter plants. Fifty-nine out of the 128 plants have used crushed limestone as a filter media. Of these fifty-nine plants reports were received with respect to disintegration on fifty-one plants of which twenty-six showed definite signs of disintegration. The results of this census indicate that limestone has been used in forty-six per cent of the trickling filter plants located by the census and that fifty-one per cent of these plants showed signs of deterioration of the filter material. This represents a rather formidable case against limestone as filter media in sewage filters. However, there are many filter beds built of limestone which have been in operation under very severe conditions for a number of years and which show no signs of deterioration whatever.

In the last few years engineers have been attempting to determine what properties crushed stone should have to insure that it will not disintegrate under exposure to weather and to the action of sewage, and also what tests should be applied to the selection of material to bring out these properties. The specifications for the material for use in the plant at Akron referred to before require quality of material as follows:

"The filtering material should be clean, sound, hard limestone rock, free from seams, flat or elongated pieces, and shall conform to the following physical requirements:

Hardness	Not less than 14 per cent.
Toughness	Not less than 5 per cent.
Wear	Not more than 6 per cent.

The stone shall show no signs of checking, cracking or disintegration by the sodium sulphate test for soundness."

TABLE II

QUANTITIES OF VARIOUS KINDS OF FILTER MATERIALS USED IN SEWAGE FILTERS

Based On Detail Data On 203 of 388 Plants Reported In Recent Census

Hundreds of Cubic Yards

State	Limestone	Trap Rock Granite Quartsite Flint	Gravel	Crushed Stone	Slag Cinders	Misc.	Total
I—States East of the Mississippi River							
Alabama	...	...	...	...	113	...	113
Connecticut	...	...	...	9	...	...	9
Georgia	...	581	...	40	...	...	621
Illinois	817	...	11	...	...	9	837
Indiana	...	...	...	...	...	...	...
Kentucky	202	...	...	...	...	...	202
Maryland	...	414	...	...	...	35	449
Massachusetts	...	2,919	...	...	...	...	2,919
Michigan	220	...	170	...	52	...	442
Mississippi	...	...	...	...	30	...	30
New Jersey	...	515	13	...	124	52	704
New York	786	...	29	...	...	...	815
Ohio	1,469	...	18	...	1,616	...	3,101
Pennsylvania	365	132	...	10	...	24	531
Rhode Island	...	...	...	13	...	...	13
Tennessee	6	2	...	...	...	...	8
Virginia	49	...	...	...	...	...	49
West Virginia	31	...	...	...	...	8	39
Wisconsin	264	...	1	...	...	...	243
TOTALS	4,185	4,563	242	72	1,935	128	11,125
II—States West of the Mississippi River							
California	...	188	24	33	...	...	245
Colorado	...	...	11	...	...	30	41
Iowa	132	114	...	...	...	...	246
Kansas	491	6	...	...	...	27	524
Minnesota	84	227	4	...	...	...	315
Missouri	357	6	...	...	...	...	365
South Dakota	...	125	...	...	...	2	125
Texas	584	114	...	...	5	...	703
TOTALS	1,648	780	39	33	5	59	2,564
			242	72	1,935	128	11,125
TOTALS, EAST	4,185	4,563					
GRAND TOTALS	583,300	534,300	28,100	10,500	194,000	18,700	1,368,900

Recently there has been a committee appointed by the Sanitary Engineering Division of the American Society of Civil Engineers to make a detailed investigation of the subject of filter materials for use in sewage and water work, particularly with reference to coarse grained filter materials for sewage work. This committee has been working for two years and have concluded that it is a difficult problem which will require a large amount of study, including extensive laboratory tests on many samples of materials with known service records before anything definite can be determined with respect to proper qualities and methods of determining such qualities which make for the proper selection of material for use as filter media in any particular installation.

This question of the proper selection of material for use as filter media should engage the active interest and attention of crushed stone producers. It is important from the standpoint of competition with other materials that there be as few failures as possible in service. This is particularly true in the limestone regions where both good and poor materials are available.

Preparation of Filter Material

Crushed stone for use as a filter material requires more special and rigid attention as to preparation than is necessary for crushed stone which is to be used as concrete aggregate. This means special attention by the producer, at the quarry and further preparation at the site of the filter plant, immediately before the material is placed in the filter bed. The typical specifications with respect to size of filter material referred to heretofore indicate very small tolerances as to variations from the prescribed sizes. A relatively small amount of material, smaller than the minimum prescribed size, has a very detrimental effect on the operation of the filter bed. Also, the filter material should be clean and free from the surface coating of dust, commonly found on crushed stone, particularly after it has been handled.

In order to obtain the sizes of material which have proven to be most satisfactory in operation, it has been usually found necessary to rescreen at the filter plant site. This means that a certain amount of material shipped for use as filter media will be rejected by the rescreening plant and must be utilized for other purposes or wasted. Usually we have found that the crushed stone producer can reduce the amount of this rejected material considerably by slight adjustments in the size and operation of the screens at the quarry. This, of course, can be more readily arranged where the quantity of material required is large and shipments are approximately equal to the capacity of the screening plant at the quarry.

In addition to rescreening the material at the filter plant site in a number of cases it also has been washed immediately before being placed in the filter bed. This practice is not commonly used. However, the results obtained by washing have been quite satisfactory and the additional cost has not been excessive. For example at Elgin, Illinois, approximately 20,000 cubic yards of filter stone was rescreened and washed at an additional cost of about $3,000. The rescreening and washing rejected about 420 yards out of 20,000 yards, or in round numbers 2 per cent. At Akron, Ohio, bids received on placing 312,000 tons of material in the filter beds indicated additional costs of twenty cents per ton where the material is rescreened before placing. Thus, if the screening at the quarry could be adjusted to make rescreening unnecessary, it would represent a saving of $62,000 in the construction of this filter plant.

Volume of Filter Material

Some indication of the quantity of material which will be required in the future as filter media in sewage filters may be obtained from the results of the census recently made of existing trickling filters throughout the United States. This census was made by a committee of the Sanitary Engineering section of the American Society of Civil Engineers, sending questionnaires to the various state sanitary engineers. Answers to these questionnaires were received from thirty-six states, indicating that a total of 388 filter plants were in operation serving an aggregate population of about four million people. The detailed distribution of these various plants by states are given in the accompanying Table 1. Detailed data with reference to the size of plant, of quantity and kind of filter material used, were received from twenty-six states, including reports on a total of 203 plants serving a total population of about three and one-third million people. This represents detailed reports on fifty-two per cent of all the plants located by the census and eighty-three per cent of the total population served.

The amount of various kinds of material used in the 203 plants for which complete reports were obtained are given in detail in the accompanying Table 2. The quantities of crushed stone which will be required for filter media will not be large compared to quantities of material required for other uses. However, there will be an increasingly larger number of sizable sewage filter plants constructed in the future. The quantities of materials required will be worth consideration.

It is hoped that standard methods may be developed for testing and selecting materials for these plants so that a minimum of unsuitable material be used. It is both an economic loss to the community and a black mark on the general reputation of any type of material whenever a filter bed containing that type of material disintegrates or fails in its function because of improper grading

COOPERATION OF TWO BASIC INDUSTRIES

By C. R. Stokes
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WHEN a comprehensive and complete study is made of the intricacies of the production of sand and gravel and the manufacture of lime, and the uses of both products, we see many things common to the two industries. Not the least of these is the existence of a trade association for each industry to represent it in its activities throughout the United States. The principles involved in these activities are essentially the same. The Associations stand between the manufacturer and the public, to collect and disseminate information, and to represent the industries before the public in all matters which affect the use of their products. Their purpose is to promote the more effective use of their products with the expectation that this will bring about a more extensive use; a larger tonnage.

They maintain membership in various business, technical and scientific organizations, with particular reference to those who promulgate standards and policies; they endeavor to correct unjust, erroneous and misleading statements; and seek to improve the position of the industries they represent by constructive work in whatever channels may be opened by ethical methods. So much for the similarity of the purpose of the Associations representing the two industries.

Let us now compare the actual workings and features of the two industries themselves, and by so doing note the continuing similarity between them. In the first place both industries operate on raw materials found in their natural state in the ground. While the manufacture of the finished product of the two industries are different in methods and procedure, the fact remains that both industries must carefully prepare these raw materials into marketable products. Considerable time and expense is involved in this preparation. The product of both industries is extremely versatile and has many uses outside of the construction field. Some of these uses are in common, as for instance the manufacture of glass, in which both sand and lime are used. In most applications sand and gravel and lime are recognized as basic materials and as such are required to pass rigid specifications.

In these respects we have then, the similar but uncombined relationship existing between these two basic products. Of greater importance, it would appear, in the interest of the two industries, is the relationship of the two products in the construction field. You as producers of sand and gravel are of course fundamentally interested in active sales for your product. In this respect we are again on equal footing in that our principal efforts are also directed toward increasing the volume of sales for lime. But we must not become so involved in this effort as to blind ourselves to another important function; that we are vitally concerned with the quality of construction our material will be used in, and the qualities of any other materials entering into the same construction.

Here then it seems to me our interests in common are more affected than by any other phase of either industry. In other words, your existence and ours in the construction field depends not alone upon the quality of our respective products but also upon the quality of our own materials taken together, in comparison with the other materials which will be used. However, more of this later when I will take up the various types of construction and try to show why we should cooperate in protecting the uses of our materials.

Before going into the construction field, perhaps it would be appropriate to define lime more clearly. Lime, like sand, is centuries old and evidences of its use in the early ages are to be found on all parts of the globe. It is produced by heating quarried limestone to such temperature that decomposition will take place and the chemical bond between the calcium or magnesium oxides and the carbon dioxide broken. The resulting quicklime must then be slaked before it can be used for construction purposes. The ordinary method of slaking quicklime, is to add sufficient water to cause the necessary action to take place. A thick paste is formed which should be thoroughly aged before using. Within recent years, however, a method has been introduced of treating lime with water in a suitable apparatus in which the lime combines with sufficient water to satisfy the chemical requirements of the calcium oxide forming a dry, finely divided powder, called hydrated lime. This material comes into the market in bags ready for use.

As previously stated, we have many things in common as applied to the construction field and I am going to attempt to show, by taking up some of the different kinds of construction, wherein these interests lie. Let us first consider the construction of highways.

Sand, gravel or stone, and cement have long been recognized, especially in concrete road construction, as the principal materials required. At first it was thought that all that was necessary to build a concrete road was to combine the three ingredients with water, place the resultant mixture between forms and allow it to harden. Very little

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consideration was given to the quality of materials or to the proportions. On such a basis the sand and gravel producer of today would have been at a loss to sell his product, for any convenient deposit was used. In fact, in those days many concrete roads were built with pit run materials, no attempt being made to separate the sand from the gravel. Fortunately for all concerned, however, engineers studying the problem, steadily developed the idea of more rigid material requirements until the present status was reached. It was found that sand and gravel must be separated, so as to be properly proportioned, that a certain gradation including minimum and maximum sizing was necessary, that the materials must be cleaner, and free from impurities which would be injurious to the concrete. These were roughly some of the steps in the evolution of concrete road construction.

Today, scattered about in nearly every state are large and efficient modern plants, preparing sand and gravel with such care, that it may be safely used in all classes and types of construction. The field is tremendous in scope, but it is not a field in which a few dollars of capital invested in inferior equipment can hope to compete with efficient, modern methods. In other words, the producer of the latter type is the one who is in business to stay, and he is also the one who is finding a ready sale for his product. The same things apply to the lime industry in no less degree and the successful manufacturer of this material has fully realized these facts.

You are probably asking wherein does lime enter the highway construction field? In recent years engineers and constructors have come to realize the advantages to be gained by adding finely powdered materials to concrete mixtures. Exhaustive tests combined with practical experience in the field have satisfactorily shown that when hydrated lime is added to concrete not as a substitute for cement, but strictly as an admixture, the quality of that concrete is improved. To be brief, lime makes concrete more workable, watertight and much more uniform; increases the density, eliminates segregation and improves its appearance and strength.

Complete information relative to and in substantiation of these functions of lime is contained in the numerous publications of the Lime Association.

For a number of years, lime has been added to concrete in all classes of building construction and in comparison, its use in the field of highway construction is somewhat new, although some states and not a few cities have been using it for some time. It has, however, come to the front more in the last few years in respect to highway construction, because engineers have realized the value of a material, which in every case where given a chance to prove its worth, performs the aforementioned functions. You producers do not want your material to go into faulty construction, and by like reasoning you will be vitally interested in a product which materially improves the quality of construction wherein your sand and gravel are essential. I do not mean to infer that lime will make a good concrete out of an inferior mix, but it will make any concrete much better. For our part we will not recommend that lime be used on a concrete project where inferior sand and gravel are being used.

There are some features in the functions that lime performs in concrete which should be of special interest to you as producers of the aggregates. Take for example the matter of concrete uniformity which is almost entirely dependent upon the consistency of the mix. Practically all of the sand and gravel shipped to road jobs today are washed materials. Naturally after their receipt at the point of destination, the moisture content will vary considerably, contingent upon several things—such as length of haul, condition of cars, etc. Quite a problem is presented on the job, in how much mixing water to use to obtain the proper consistency. In these days of terrific speed in construction, too little consideration is given this matter, the result usually being the use of a predetermined quantity of water. The effect, providing the operator knows his business well enough to get approximately the same amount of water into each batch, is often rather staggering. A wet batch follows a dry one, because there was just enough moisture in the material to make that difference. Five per cent of lime per sack of cement will easily take care of this extra moisture and allow the batches to be deposited with an even consistency. The reason for this is that the lime, having a higher affinity for water than cement, readily takes up the surplus moisture.

Another point of importance is the matter of workability. It is a known fact that sand and gravel as manufactured at an efficient plant and placed in the bins is for all practical purposes in its maximum state of perfection as to gradation. Unfortunately, very few road projects can be built by direct truck haul from the plant, but rather the materials are usually handled and rehandled several times before entering the paver. The result is often a concrete containing a preponderance of coarse gravel or a mix in which only the coarse sand is present. Increased workability is sometimes sorely needed to handle just such aggregates. Especially is this true in respect to coarse sand, which although producing high mortar strengths often tries the patience of the most astute contractor when it comes to finishing. They are all willing to concede when using lime under such conditions, that their placing and finishing operations are made much easier. Lime imparts to the concrete mix a plasticity which in itself has the appearance of added sand. These are but a few of the advantages to be obtained by using lime in highway concrete, which of course includes bridges and culverts.

I want to also touch briefly on our relations in the field of asphalt paving, particularly sheet asphalt. Sheet asphalt, as probably you all know, is made up of sand, bitumen and filler. Until recently, to all intents and purposes only certain materials such as limestone dust were accepted as suitable fillers. However, exhaustive investigations have proved that the fineness and texture of the filler almost wholly controls the stability of a sheet asphalt paving mixture. Hydrated lime, because of its texture and extreme fineness, has been found particularly suitable. But it seems to me that the thing of great importance from the standpoint of our mutual relationship, is the fact that lime as a filler functioned differently from ordinary fillers when different sand gradings were taken into consideration. At the present time specification requirements for sand for bituminous paving mixtures are extremely rigid and only sand passing a certain very strict gradation classification is used. These requirements are based to a large extent on the void filling capacity of the fillers used.

Investigations by the Asphalt Association proved that lime increased the maximum stability of sheet asphalt mixtures from 15 to 20 per cent over other fillers when what has been considered as poorly graded sand was used. This particularly applied to fine sand, which is a waste or dead loss around most sand and gravel plants. In other words, a large amount of this waste sand could be utilized in bituminous paving mixtures if lime is used as the filler, and thereby converted into a profit rather than a loss. At least we are convinced that the present rigid requirements can be moderated with the change in fillers, so that many more sand and gravel plant owners could produce asphalt sand in connection with their present product.

So much for highway construction, although I have merely touched the field and its possibilities. A paper of this nature could hardly be complete unless some mention was made of that other great field in which sand, gravel or stone and lime are paramount, namely—the construction of buildings. In the erection of the modern type building, these materials are important ingredients in the concrete, brick mortar, stucco and plaster which constitute the structure. They must be of unquestionable quality, for the safety and appearance of the building is largely dependent upon them.

The mixing and placing of concrete in buildings is essentially the same type of problem encountered in highway construction. However, it is often complicated by the fact that leaner mixes are used, the concrete is usually delivered by long chutes, and the network of reinforcing steel makes its proper placement more difficult. Steady development in the sand and gravel industry has resulted in the efficient production of materials well graded from fine to coarse particles, which in themselves should make a workable concrete. Notwithstanding this, the best directed efforts of sand and gravel producers are often defeated by the use of long chutes on the work, which cause the fine material to separate from the course, and also by the extreme difficulty encountered in placing concrete around reinforcing steel.

Lime is best known by its two properties of stickiness and slipperiness. In concrete the stickiness of lime acts to prevent segregation, in other words the mortar will not become separated from the aggregates in placing. Its slipperiness eases the concrete down the chutes and into the forms with an actual saving of labor. This labor saving is nowhere more conspicuous than in complex reinforcing, where the use of lime insures maximum density and reinforcing bond with the minimum of ramming and patching.

Thus the addition of lime to the concrete enables the contractor to use the most economical methods of placing it, and at the same time obtain a good job. This is a point not to be overlooked, for many contractors are prone to ascribe blame for poor workmanship to unsuitability of materials. Lime used in conjunction with properly graded sand and gravel in structural concrete will insure successful results that are certain to be reflected in a more extensive use of these materials.

Plaster, stucco and mortar are all greatly influenced by the kind of sand with which they are made. The first requisite of a good plaster, stucco or mortar is that it be workable, since quality of workmanship is generally of far more importance than strength. A great deal of attention has been given to the grading of sand for these purposes and in numerous instances very rigid specifications have been written in the attempt to secure a sand that the workman will consider proper for his use. At the same time the proportion of cementitious material has been reduced to the minimum for economy, thereby throwing upon the sand producer the burden of supplying workability. In this connection, the use of lime is of great importance to the sand producer, for it has a higher sand carrying capacity than any other cementing material and produces the greatest smoothness and workability. Furthermore, it has been found that within certain limits, the rigid requirements as to sand grading are unnecessary if lime is used. This is a fact which should be taken advantage of by the producer in extending the uses of his sand to fields otherwise closed to him or to compete on a more even basis with the special sands which heretofore held the advantage in quality of finish and workability.

Stucco construction further offers the sand and gravel producer an excellent opportunity to increase total tonnage and to dispose of certain off-sizes. The requirements of sand for this purpose are practically the same as for plaster or mortar and no special stocks are needed. Lime stucco is also of special interest to the sand producer because its pure white color enables the workman to obtain many pleasing color effects by using only a sand, without the addition of other coloring materials. By this method it is possible to develop many of the soft, delicate colors in stucco which are so pleasing to the eye, while at the same time the surface texture may be varied by adding small sizes of gravel.

By the foregoing I have attempted to illustrate in the time allotted for this paper, the direct relationship between two important industries and by sc doing, bring out some of the features in the combined uses of both products in every day construction, to emphasize this relationship.

In closing, I would like to mention the production of a commodity which appears to offer splendid possibilities for the disposal of sand and lime, namely the manufacture of sand-lime brick. Sand-lime brick is not what could be called a new product, but its development until very recent years was retarded by faulty promotional efforts and other like causes. It has many advantages, not the least of which is the fact that it has placed within the reach of users, a cheap, durable noncombustible building material with reasonable transportation costs. Another very marked advantage enjoyed by this type of brick is the fact that it is ready for delivery to the job 24 hours from the time its manufacture is started.

Sand-lime brick, as now known to the trade, consists essentially of sand bound together by lime, the sand constituting from 88 to 95 per cent of the total. It is naturally light in color, ranging between buff and white. Its method of manufacture insures a high percentage of uniformity in regard to size, shape and surfaces. This type of brick goes on the market under the classification of common building brick and as such it must meet the same requirements as to hardness, porosity and crushing strength.

In the manufacture of such a brick, a reasonably good quality of sand is desirable, since this factor may determine the selling price of the finished product. In this connection another important factor making for moderate production cost is the cheapness of the sand and for this reason it would undoubtedly be a mistake to urge all producers to attempt to sell sand to manufacturers of sand-lime brick. But to the producer of sand and gravel, who has a large sand waste on his hands, in other words, more than he has a market for, the manufacture of sand-lime brick in connection with his regular operations should offer very interesting possibilities. It is an industry in itself on a practical paying basis which has been beneficial not only to the manufacturers themselves but also to the general public. Almost everyone has a direct personal interest in building materials, and sand-lime brick has achieved a permanent position on merit.

Testing Explosives by Photography

An investigation to determine by photographic methods the effect of the physical and chemical properties of explosives on the flames produced, and the influence of different methods of loading and different kinds of stemming on the character of the flame, together with the relation of flame properties to the limit charge as determined in a testing gallery, is being conducted by the Bureau of Mines. Photographs on a rapidly moving film have shown that secondary flames are produced by most explosives when an air space exists between explosive and bore hole or between explosive and stemming. Photographs on a fixed plate have shown coal-dust stemming to produce a large bright flame, much larger than with fire-clay stemming, and that addition of water to ordinary dry fire-clay stemming reduces size of flame. Results are in qualitative agreement with gallery tests.

The purpose of another investigation being conducted at Pittsburgh is to determine the mode of ignition of gas and dust by a charge of explosive fired into a steel gallery. The gallery contains a horizontal slot covered by plate glass windows through which the flames may be photographed on a rapidly moving film. The gallery has been constructed and a camera designed and built which has a 6-inch drum capable of revolving at peripheral speeds up to 50 meters per second. It is hoped by means of this apparatus to obtain more definite knowledge as to the mechanism of mixtures of air with gas or coal dust. Another study undertaken is for the purpose of determining the rate of detonation of explosives by a new method, namely, photography of a detonating column of explosive on a rapidly moving film. Rates of detonation of typical mining explosives have been determined by this method, and the propagation of the shock wave over an air gap between two cartridges also has been studied.

Safety of Cushioned Blasting

The relative safety of cushioned blasting as compared with shots in which no air space exists between explosive and stemming is being studied by the Bureau of Mines at its Pittsburgh experiment station. During the past fiscal year series of tests have been partly carried out to determine the charge limit of a permissible explosive in 8 per cent natural gas-air mixtures under the different methods of loading in the borehole, and using different kinds of stemming. During the present fiscal year it is planned to complete the above series and include natural gas-air mixture of less than 8 per cent natural gas.

STONE DUST, ITS USE AND PREPARATION

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ROCK DUST might be defined in several ways, but as the term is here used, means finely divided rock particles reduced by mechanical means from hard rock fragments. It may be obtained as a by-product in the crushing of rock primarily to secure the different commercial grades of crushed stone or by crushing and grinding all of the stone. Rock dust may be obtained from limestone, marble, slate, sandstone or the silicate rocks, but that obtained from limestone and marble constitutes by far the greatest amount as it has wider distribution and more commercial uses than any of the others. Slate dust, pulverized slate or slate flour is used to some extent as a filler for asphalt pavements, in plastic cements, various moulded articles of manufacture and has been tried in linoleum and rubber. While used to some extent in these two latter materials, it has not proved as satisfactory as hoped for. Its production is limited to certain restricted areas, so is handicapped for general use as a substitute for other materials. Red slate flour is sometimes used as the pigment in paint for the burlap backing of linoleum.

Most dusts resulting from the grinding of sandstones are too impure to compete with pulverized sand, so abrasive uses are about the only outlet for this material, and available markets are decidedly limited.

The silicate rocks, such as granite and trap rock, would never be used primarily as a source of rock dust. In the preparation of commercial sizes, however, a certain amount of fines are unavoidably produced and constitute a by-product for which the quarryman desires to find a market. Due to its physical and chemical properties, it has little or no fertilizer value and cannot be used for mine dusting. Also, mainly due to its physical properties, there is little hope of its finding application in the field of high grade fillers, so silicate screenings are more or less restricted to structural uses as fine aggregate to replace sand. If ground sufficiently fine, they may find some outlet for abrasive purposes.

Limestone and marble dust may be divided into two general classes; first, comparatively coarse, material including agricultural limestone, dust for mine dusting, asphalt filler, and as a stock food ingredient; second, extremely finely ground products used mostly as a filler in various manufactured articles. The quantity produced of the first class greatly exceeds that of the second, but the price is much less, for restrictions as to fineness, color and chemical purity are not so hard to meet and the market is much greater. For most purposes marble dust may be used the same as limestone dust.

Use of Limestone Dust

Agricultural limestone is used to correct acidity in soils and as a soil conditioner. The benefits to be derived from its use are so well known that no discussion of its merit is needed here. Some states have advanced more than others in its use, but the general tendency is for a widening of its application and it is safe to predict that there will be a rapid increase in consumption, not only in the districts where it is now employed, but in new territory, as the benefits to be derived are realized by the farmer. One disadvantage of this business is its seasonable character, making necessary the accumulation of large stocks by the producer and wholesaler, or else the curtailment of production during the slack season, and very few producers are prepared to store large quantities in pulverized form. Possibly seasonable demands may be partly overcome by proper educational campaigns and the offering of special inducements to the consumer during the slack season. This is being done to some extent.

There has been much discussion as to the proper fineness for agricultural stone. Coarser stone takes longer to become available, but it is cheaper. More finely ground stone is more rapid in its effect, but may have a tendency to pack in bins and bags and is sometimes more difficult to properly mix with the soil. Chemical purity is important only to the extent of having to pay freight and handling charges on inert material. Magnesium limestone is now by some authorities considered equally as good as high calcium stone, and other things being equal, they should be practically an equal rating. There are certain special conditions, however, where one or the other might be superior. There would be no advantage to either the producer or farmer in the establishment of rigid specifications, as what the farmer desires is a satisfactory product at the least price. This means a different product under different conditions of supply, cost of transportation, and length of haul from the railroad.

The following table, figures for which were furnished by the Statistical Division of the U. S. Bureau of Mines, gives the production and value by states for the year 1925. There was an increase of 45 per cent in tonnage and 41 per cent in value over 1925. The average selling price at the plant was $1.42 per net ton.

*Presented before the Tenth Annual Convention of the National Crushed Stone Association on January 19, 1927.

LIMESTONE FOR AGRICULTURAL PURPOSES SOLD OR USED BY THE PRODUCERS IN THE UNITED STATES IN 1925, BY STATES

State	Short tons	Value
Alabama	(1)	(1)
Arkansas	(1)	(1)
California	11,530	$ 37,584
Connecticut	(1)	(1)
Georgia	24,150	35,050
Idaho	(1)	(1)
Illinois	638,490	589,797
Indiana	127,220	125,685
Iowa	93,010	71,722
Kansas	2,120	3,991
Kentucky	39,420	48,972
Maine	(1)	(1)
Maryland	(1)	(1)
Massachusetts	36,980	210,314
Michigan	223,480	183,806
Minnesota	20,220	18,073
Mississippi	(1)	(1)
Missouri	40,090	54,668
Montana	(1)	(1)
Nebraska	(1)	(1)
New Jersey	(1)	(1)
New York	71,650	218,777
North Carolina	(1)	(1)
Ohio	230,270	280,747
Oregon	(1)	(1)
Pennsylvania	102,710	399,053
Porto Rica	(1)	(1)
Tennessee	79,230	135,520
Texas	(1)	(1)
Vermont	(1)	(1)
Virginia	44,860	76,686
Washington	(1)	(1)
West Virginia	12,100	30,445
Wisconsin	55,900	85,038
Undistributed	101,050	275,252
Total	1,954,480	$2,880,589

(1) Included under "Undistributed."

Rock dust properly applied is now known to be a positive preventative of the propagation of dust explosions in coal mines. All bituminous coal dust is explosive and when stirred up into the mine atmosphere by a small gas explosion or defective blast, creates a condition favorable to a destructive explosion and mine disaster. England has mine regulations requiring the rock dusting of gassy and dusty mines. Other European countries recommend its use. In the United States no regulations are in effect, but rock dusting is strongly recommended by the Bureau of Mines, and many demonstrations of the explosibility of coal dust and the effect of rock dust in rendering it non-explosive have been made at the Bureau's experimental mine near Pittsburgh. Rock dust is being used in many mines in Pennsylvania and West Virginia and in some of the mines in Illinois, Indiana, Kentucky, Alabama, Wyoming, Utah and New Mexico, but probably not more than 20 per cent of the coal mines of the country are at present being rock dusted. Instances are on record where dusting has undoubtedly prevented serious disasters. While standard specifications for rock dust for mine use have not been adopted, tentative specifications have been proposed in the U. S. Bureau of Mines Serial No. 2606. Some abstracts from this are as follows:

"Standard rock dust for use in rock dusting of coal mines might be defined tentatively as powdered mineral, light colored and free of carbonaceous matter and free silica, all of which will pass a twenty mesh screen, while 50 per cent of it will pass through a two hundred screen."

"Such dust may be prepared from limestone, gypsum, anhydrite, or shale free of sand and flint. For the initial rock dusting of the average non-gaseous bituminous mine enough standard rock dust should be applied so that the combustible content of the resulting mixture of rock dust with mine dust shall not exceed 45 per cent, a range somewhere between 35 per cent and 45 per cent being the practical objective sought."

Mine conditions as to character of coal dust and amount of gas in the mine air may allow, or make necessary, modification of these requirements. As coal dust is always being formed, redusting must be practiced so there is a steady consumption of rock after the original dusting. A light colored dust is always preferable as it gives an indication of the amount present and aids illumination. No figures are available as to the total consumption in the United States, but its use is increasing rapidly. The amount consumed in any one mine is manifestly controlled by the amount of coal dust made and length of mine openings. The initial dusting may require from ten to fifteen tons of rock dust per mile of roadway or mine opening. Redusting during the year will generally require an amount greater than this.

Asphalt pavement mixtures require the addition of some inert mineral filler to make the mixture less susceptible to temperature changes, to toughen the mixture and aid in reducing the cost by acting as a harmless dilutant. The weight of filler used is approximately equal to that of the asphalt cement and the total filler used is in the neighborhood of one and one-half million tons per year. Other fillers, such as slate flour are used but limestone is the most common, partly because its physical properties are not severe. Color is immaterial and dust from both fine and coarsely crystalline limestone is used. While all types of limestone dust are used, no doubt some would be better than others, but so far no comprehensive research to determine this has been carried out, and price is usually the controlling factor in making the selection. Specifications usually require that one hundred per cent shall pass a No. 30 standard sieve and at least sixty-five per cent shall pass a No. 200 sieve. Stone dust is used as a filler in moulded asphalt blocks and asphalt joint filler for the different forms of block pavements, but the total consumption for these uses is not large.

High Grade Stone Dust

High grade stone dust includes those used where color, texture, fineness of grain and chemical composition are collectively or individually important. Limestone and marble are the principal raw materials from which such stone are prepared. There are several reasons for this. The color is usually white or nearly so, and the finished product can thus be dyed or colored to suit. Excessive amount of grit is usually absent, and this is often a requirement. Most limestones and marbles are easily ground, permitting a cost of production that makes the marketing possible. Limestone dust, or whiting as it is usually called, cannot be used as a filler when the finished article is subjected to the action of acids. In such cases some of the forms of silica are commonly employed. Total production 250,000 to 300,000 tons per year.

Pulverized limestone is used as a filler in rubber, putty, paint, linoleum, kalsomine, soap, plasterboard, and many other articles of lesser importance. Rubber, putty, paint, linoleum, and kalsomine account for probably 90 per cent of the consumption. Some of the lesser uses are tooth-paste, shoe polish, metal polishes, and similar products. For rubber the dust must be white or nearly so. Grit must be absent. Small amounts of magnesium carbonate are not objectionable. There is no standard fineness, but most manufacturers wish a product 98 per cent of which will pass a No. 300 sieve. Free alkalies must be very low, but most natural stone meets this requirement.

For putty, extremely fine grinding is not essential. A product, all of which will pass a No. 150 mesh with over 90 per cent passing a No. 200 mesh, is satisfactory. Chemical purity is not important if the free alkalies are low. Texture, a character of the grain surface is most important. Ground marble makes a putty which is "short" and unsatisfactory. Chalk makes the best putty and very fine grained limestones, like some of the oolitic varities, make a fair grade.

For paint, color is of first importance. The stone dust must be white and the finer it is ground the better. Chemical purity is unessential as long as free alkalies are low as alkalies react with the vehicle. In rubber they effect the action of the organic accelerators. Oil absorption should be low as linseed oil costs more than whiting. Whiting for linoleum should be white for although linoleum is usually colored, the manufacturer wishes to control the color entirely by the use of dyes or colored pigments, and an off color whiting would affect the desired shade sought. Extreme fineness is not essential, in fact, is undesirable. Grit must be absent, but the texture or character of the surface of the grains does not seem of extreme importance, as whiting from highly crystalline limestone is satisfactorily used. Most kalsomines consist of about 80 per cent whiting, 20 per cent white clay, and pulverized glue for a binder. The whiting must be white and is usually ground so that 98 per cent will pass a two hundred mesh sieve. Chalk is better than limestone whiting as it does not settle out so rapidly, is more opaque, and brushes better. Some grades prepared from limestone are, however, used. Chemical purity is not essential. Most of the grades used for this purpose are ground wet.

Some limestone dust is used as an abrasive in certain soaps or hand cleaners. It is a comparatively coarse product, about all passing a sixty mesh sieve. Chemical purity is not important, but the color should be light. For plaster board a white product is essential and the stone is ground to medium fineness.

The quantity of whiting used in tooth paste is negligible as compared to other commercial uses. Very little natural stone dust is used as the best grades of paste use only a calcium carbonate precipitated from a lime solution. Metal polishes require a whiting free from grit, and preferably light colored. The fineness depends upon the grade of polish made.

Ceramic Whiting

Ceramic whiting is the different forms of calcium carbonate used in glazes, enamels, and rarely, in ceramic bodies. Chalk is occasionally used but by far the greatest amount consists of pulverized marble and limestone. It should be uniform in quality, both as to fineness of grain and composition. It should be practically free from particles of pyrite, iron bearing silicates, metallic iron and gypsum. It is usually divided into two classes or grades, one a high calcium and the other permitting a considerable amount of magnesium. The first class should contain not less than 96 per cent calcium carbonate, with not more than 2 per cent magnesium carbonate. The second class should contain not less than 89 per cent calcium carbonate and not more than 8 per cent magnesium carbonate. In both classes, iron oxide should not exceed 0.25 per cent, the silica 2 per cent, and the total sulphur computed to SO_3 0.1 per cent. Ninety-nine per cent should pass a No. 140 sieve and 98 per cent a No. 200 sieve. At least 48 per cent should be finer than 0.01 m.m.

Calcium oxide is a necessary constituent of glass. It may be used in the form of quicklime, hydrated lime or pulverized limestone, depending upon conditions of manufacture and price. Some manufacturers require a high calcium stone, while others require one high in magnesium. One manufacturer stated that in making sheet and window glass by the drawing process, the use of a high magnesium limestone prevented devitrification, which caused trouble if a high calcium limestone were used. A material in which the ratio of lime to magnesia was as 7 to 3 was considered desirable. Iron is undesirable and should not exceed 0.2 per cent for good glass. The combined calcium and magnesium carbonates should not be less than 97 per cent. The crushed and sized stone must be free from chert, flint, clay or overburden debris. A fairly coarse product compared with other grades of stone dust is desirable, for a product all passing six mesh and retained on thirty mesh is ideal. Often the fines are not entirely screened out.

Prices

Wholesale prices of stone dust, or pulverized limestone, vary between quite wide limits, depending on the location, competition and quality of the product. In November, 1926, agricultural limestone was quoted all the way from $1 per ton for a product of which 50 per cent would pass one hundred mesh to $6 per ton for material 90 per cent of which would pass one hundred mesh. Intermediate quotations seemed to be based more on the price that could be obtained, rather than on any specified quality, as quotations of $1.35 per ton for material running 90 per cent through one hundred mesh were noted, as well as $3.50 per ton for material all passing fourteen mesh. The bulk of production, however, is sold for between $1 and $2 per ton. Stone dust for mine dusting is quoted at from $3 to $5 per ton, depending on location and whether shipped in bags or bulk.

The price of high grade fillers varies quite as much as that for agricultural limestone. Probably some grades, 98 per cent of which will pass a No. 200 sieve, sell for as low as $5.50 per ton. Material suitable for rubber, paint, putty, etc., sells for from $7 to $15 per ton at the plant, depending on purity, fineness and location. Whiting or high grade stone dust is nearly always shipped in bags.

Preparation

Methods of preparation of stone dust are of as much interest to the producer as the various commercial uses of the product. Equipment is selected which will produce the desired grade at the least cost, all things considered. This requires considerable investigation as some manufacturers are prone to recommend their machines for any kind of service. In installing new equipment the operator will usually be guided by the experience of others producing a similar product from the same kind of raw material. Equipment which would be suitable for pulverizing agricultural limestone obviously would not do to make high grade whiting, and a machine suitable for the latter would not be efficient on agricultural limestone.

The coarser grades of stone dust were originally obtained as the fines passing the dust jacket on the coarse crushing plant screens. Very considerable amounts are still so made, but the rapid increase in consumption has in many cases made the installation of an auxiliary plant advisable which takes this dust from the screen and also such other fine sizes as cannot be readily marketed or on which a better profit can be made in the form of pulverized stone. At the majority of plants stone dust is a side issue, and the feed going to the pulverizer has already been reduced to the proper size in the primary crushing plant. If it has not, necessary crushing machinery is required but this is of the usual type.

For agricultural limestone, three types of crushers are employed, the hammer mill, the ring roll, either horizontal or vertical and the ball mill. The hammer mill crushes largely by impact and shearing, the ring roll mostly by pressure and abrasion, and the ball mill by impact and abrasion. The hammer mill has a large capacity and low first cost calculated on a tonnage basis. However, it is not suited for very fine grinding, and, if the market demanded such a product, it would have to be operated in circuit with a screen, the oversize being returned to the mill. This, with the necessary elevating equipment, would increase the first and operating cost. Also, the proportion of extremely fine material would be less than in that of the products from the other two types. Where the market will take its product it is probably the best pulverizer to use.

There are several forms of ring roll pulverizers on the market. In some, the mullers or rollers are pressed against the grinding ring by spring pressure, and in others by centrifugal force. They are susceptible to considerable adjustment for size of finished product. Their capacity is good unless an attempt is made to grind too fine in one operation without a screening or separation of the product and return of the oversize to the mill. Some forms operate with an induced current of air through the mill to remove the fines as rapidly as reduced, and these are more especially suited to fine grinding for other purposes than agricultural stone. In others the product is immediately discharged from the mill and the separation of oversize made on screens and classifiers. These consume less power per ton of material ground, but require more mill-space and introduce additional dust problems. The capacity of ring roll mills like all others is greatly affected by the degree of fineness of grinding. Very fine grinding with any type of pulverizer is attained only at the expense of tonnage. Maintenance charges on ring roll mills are probably greater than either of the other types, due partly to their greater mechanical complication.

Ball mills have been but little used in the production of agricultural limestone, but they have some very desirable features, which should recommend them for this duty. They are very simple in a mechanical way, have fair capacity and maintenance charges are low. For agricultural stone, a short mill of large diameter using steel liners and balls is the most efficient type. Hardinge conical mills fall in this class. For the finer grades of agricultural limestone, asphalt filler, and for rock dusting, the discharge is sometimes accomplished by drawing a rapid current of air through the mill to sweep out the material, which has been reduced to the proper fineness. The suspended dust particles are separated in a cyclone collector and the air returned to the mill in a closed circuit. Otherwise, the discharge through the trunnion of the mill is passed over screens or through air separators to remove the oversize. For coarser grades of agricultural limestone, screening may not be necessary unless the mill is crowded to capacity. Very hard rock, such as sandstone, quartizite, trap rock and granite can be successfully pulverized in a ball mill, which could not be handled in the other types on account of the hardness and toughness of the rock. In the preparation of whiting and high grade filler material, quality must come first; capacity is secondary. Ring-roll mills or tube mills are usually employed. Ring-roll mills always grind dry, while tube mills may be operated wet or dry, although wet grinding is only employed in the preparation of the finest grades.

Ring roll mills, in which the fines are removed by a current of air sweeping through the mill, is the form usually used although there is no reason why those with gravity discharge may not be employed. The former types, however, are self contained and by operating in a closed air current partly solve the dust problems which is a troublesome one around dry grinding plants. The air system is also usually equipped with an air separator or classifier as an integral part, the oversize being returned automatically to the pulverizer. If the mill has a gravity discharge, the air separator is operated as an independent unit. Ring-roll mills, in connection with an air separator can produce material, 98 per cent of which will pass a three hundred mesh sieve, but, of course, the capacity is very much less than when grinding to, say one hundred and fifty mesh. They can handle all grades of limestone and dolomite, but especially suited to the softer grades of stone. Possibly ceramic whiting could not be made from a hard stone on account of contamination with particles of metallic iron. Probably more whiting is prepared in ring-roll mills than in any other kind.

Tube mills are used to a considerable extent in grinding the better grades of whiting and must always be used if a wet ground product is desired. Their use is probably increasing. They may be of the usual cylindrical form or of the conical type with an elongated cylindrical central part. If contamination with fine particles of metallic iron is not objectionable, steel or alloy steel lining is used with steel balls as grinding media. For the best grades and ceramic whiting the mill is lined with flint block, and flint pebbles replace the steel balls. Greater capacity is obtainable with steel balls than with pebbles. Tube mills may be operated with the ordinary trunnion discharge or be operated on the air swept principal. In either event, classification or removal of oversize is done outside the mill. It is almost certain that the ordinary discharge will yield a product with a greater percentage of very fine particles, than the air swept mill, that is particles much finer than the opening in any sieve that can be made, say 0.005 m.m. The air swept mill has greater capacity.

The fineness of the finished product can be controlled by regulating the feed and varying the pebble load, but some time must elapse before the change takes effect. In this respect, the ring-roll mill, with self contained air classifier, is superior as adjustments of the classifier can be quickly made and are immediately effective.

Sizing or Classification

If specifications demand a product, all of which must pass a certain mesh, some form of separator or sizing device must be employed to secure the greatest efficiency from the pulverizer, as the capacity is greatly reduced if an attempt is made to grind to a fixed maximum size in one operation. In dry grinding, screens or air separators are the only means available.

Screens may be of cylindrical rotating or flat vibrating or shaking type. Twenty mesh is about the limit of fineness for revolving screens and even with this size the efficiency is low. Vibrating or shaking screens as fine as one hundred and fifty mesh have been employed, but the capacity is small and the cost of screen cloth replacement is high. The mistake is often made of providing insufficient screening surface. Generally speaking, sixty mesh is about as fine as can be used efficiently and for finer material better results are obtainable with some form of air separator although the result may not be as positive. The principle of all forms of air classifiers is much the same. The finely ground material is dispersed in a current of air which has a proper velocity to carry off the particles sufficiently fine and drop out those that are too coarse. This result is accomplished by various mechanical means. In some, the dust is thrown in to a rising current of air by centrifugal force acting in a horizontal direction. In others the coarse particles settle out of a horizontal air current and in others the fines are carried upward with the rising current, while the coarse grains drop back into the oversize compartment of the separator. The material must be sufficiently dry so that good dispersion of the particles in the air is possible with a minimum of grains adhering to each other.

If wet grinding is practiced, water classification is employed. A number of types are available. This is followed by thickening and filtering to remove excess water or by sedimentation, which is slower but requires less mechanical equipment. Drying of the wet pulp is accomplished in different forms of dryers, but those in which steam is the heating medium are more satisfactory, as great care must be exercised not to overheat the product. Film dryers in which the whiting in suspension in the water is sprayed on the surface of a revolving drum internally heated by steam have proved quite satisfactory. The cost of drying is the reason for the increased total cost of the wet process, as the capacity of a tube mill grinding wet is greater than when grinding dry.

Cost of Grinding

Grinding costs manifestly depend upon many factors, such as toughness of rock, capacity of plant, power cost, fineness of grinding, and type of pulverizer used, and generalized figures only, even for the same grades of rock dust, can be given. In the estimates following, only the costs beginning with the stone small enough to feed to the pulverizer are considered, and quarrying and preliminary crushing are not taken into account. A manufacturer of a pulverizer of the ring-roll or ring-ball type estimates the cost per ton with capacity of four tons per hour to 90 per cent through one hundred mesh as 56 cents per ton. This takes into account, depreciation, interest, repairs, power at one cent per K.W. hour, and labor 50 cents per hour.

A manufacturer of hammer type pulverizers for agricultural limestones estimates the cost at 20 cents to 60 cents per ton depending on the hardness of the stone and size of the plant. A manufacturer of an air swept ball-mill states that the average cost of pulverizing is about $1 per ton, less than this for a one hundred mesh product and considerably more than two hundred or three hundred mesh material. This obviously is guess work.

A manufacturer of a ring-roll mill gives the cost at a capacity of five tons per hour to 75 per cent through two hundred mesh, a rather fine agricultural stone, as 57 cents per ton. This included depreciation, maintenance, interest, power at three cents per K.W. hour and labor at 60 cents per hour. The same manufacturer estimates the cost at three tons per hour to 95 per cent through two hundred mesh as 87 cents per ton and 1.5 tons per hour to 99 per cent through three hundred mesh as $1.62 per ton.

A manufacturer of a special ball or tube mill, grinding eleven tons per hour to 50 per cent through two hundred mesh, gives the cost at 31 cents; with a capacity of seven tons to 80 per cent through two hundred mesh for asphalt filler, as 47 cents; with a capacity of four or five tons to 96 per cent through two hundred mesh, as 67 cents; and three tons to 99.5 per cent through three mesh as $1.12 cents per ton. These estimates include power, labor, repairs, interest and depreciation. This mill operated in a closed circuit with an air classifier. A manufacturer of grinding equipment estimates the cost at a plant grinding twenty tons per hour wet in combined ball and tube mills as $1.07 cents per ton. This includes overhead, labor, repairs, power at two cents per K.W. hour and maintenance. The estimate of overhead which covers depreciation, interest, taxes and insurance, is 65 cents per ton, which seems out of line.

Estimates of costs made by manufacturers must of necessity be quite generalized unless applying to some particular installation, and they are usually based on ideal conditions and do not include management and supervision charges which may be considerable for a plant of small capacity. Also, it is impossible to take the character of stone into account. Actual figures often vary to an absurd degree, due to peculiarities of the plant and grindability of the stone, which latter may vary by as much as 100 per cent. Also, a few per cent more or less retained on a certain screen may have a great influence on capacity, and therefore on the cost.

Summary

The stone producer who considers entering the stone dust field for any reason has a problem to consider from a great many angles. He may have a waste product on hand on which quarrying and crushing costs have already been written off. The question then is, can he put this into such shape that it can be marketed at a profit. Available markets are of first importance. This included not only the quality of material for which a market exists, but their location with respect to competition from other sources and distances from the producing plant. If markets can be reached, a study of his raw material must be made to see if it meets the particular requirements. Then must follow an estimate of the cost of the plant and cost of operation, which, of course, is controlled by the capacity, and quality of the material which it is proposed to produce.

Oxygen in Air

Normal air contains about 21 per cent of oxygen. Man works best at this proportion of oxygen. A candle or oil flame will not burn in atmospheres containing less than approximately 16½ per cent oxygen, yet man is sufficiently adaptable to get along fairly well in 17 per cent of oxygen. He will breathe a little faster and a little deeper. The effect is about the same as going from Pittsburgh to Denver, Colorado, with elevations of 630 to 5000 feet, respectively. But most men can not work in air with oxygen below 13 per cent, the point where an acetylene flame is extinguished by oxygen deficiency. No one should ever enter an atmosphere where an acetylene flame goes out without an oxygen breathing apparatus or an air hose-mask. In an atmosphere containing between 10 and 13 per cent oxygen, men become dizzy, pant, have a rapid heart beat, and often suffer from headache; 8 to 10 per cent usually produces unconsciousness and ultimately death.

ANOTHER BRIXMENT MILL COMPLETED BY LOUISVILLE CEMENT COMPANY

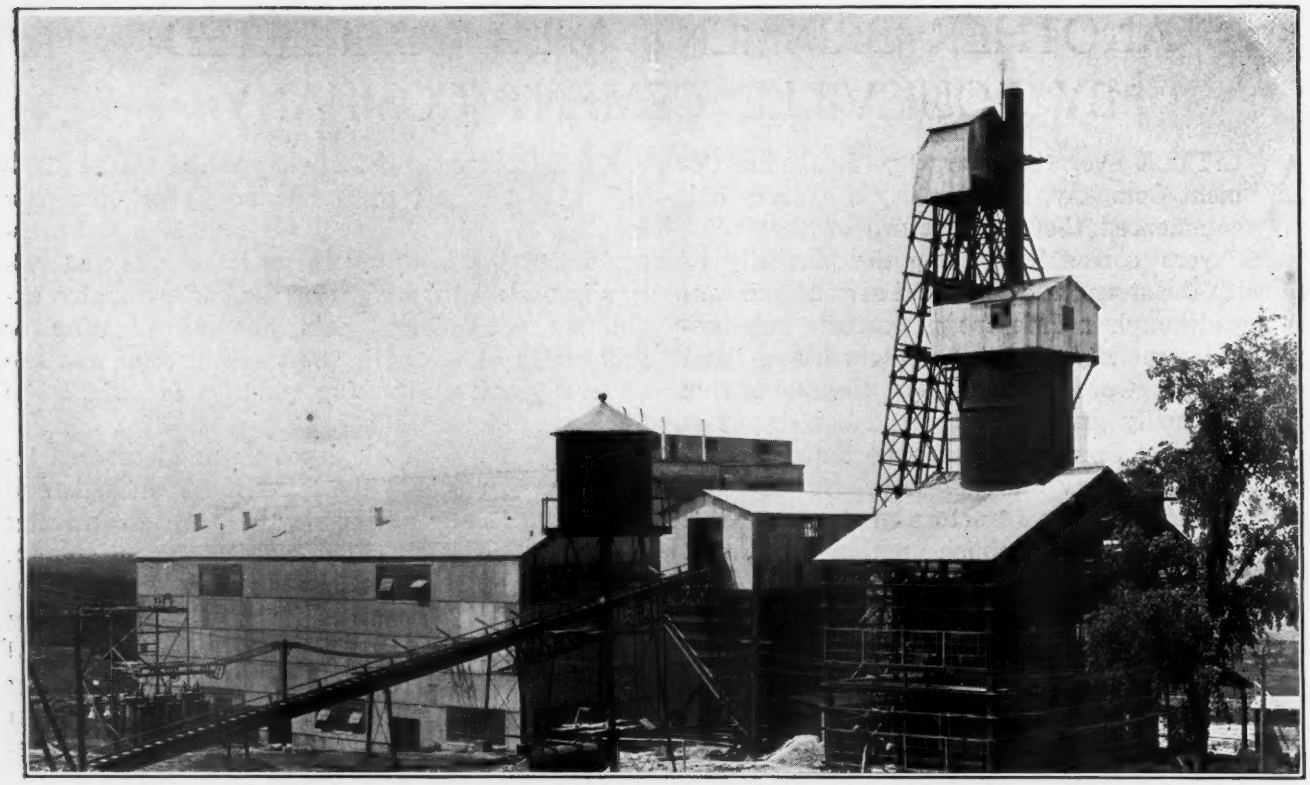
A LITTLE over ten years ago Louisville Cement Company, itself nearly a century old, commenced the manufacture of Brixment, a bricklayers' cement combining the plasticity of lime with the strength of portland cement and containing, although in different proportions, substantially the same chemical ingredients as portland cement itself. Once on the market, the sale of this product actually grew by leaps and bounds. The original mill at Speed, Indiana, was taxed to production. Its capacity was increased. But the continued demand from contractors in the east soon made it necessary to establish another large mill, conveniently located in some eastern state.

The building of a new mill for a product like Brixment, however, was not like building a new plant for automobiles, soaps or furniture. Something more than a favorable shipping point, the erection of buildings and the installation of machinery was necessary. To insure uniformity and dependability of product, certain special rock deposits possessing a rare combination of properties had to be located in one of the eastern states. This was a matter not of a few weeks or of a few months. For over three years engineers and prospectors of the company roamed the hills and valleys in no less than eight of the eastern states examining rock deposits, making analyses, testing for uniformity of strength, lightness in color and the unusually smooth-working qualities for which the finished product is noted.

Finally, a huge rock deposit was discovered located near Buffalo at the town of Akron Falls and containing ideally all the requirements for making a finished product of unquestioned uniformity, strength and architectural beauty. Work commenced. Today a modern plant of large capacity from which every town in the east can be supplied with Brixment is working full time, the growing demand is being satisfied and the town of Akron Falls—home of the workers—has been appropriately rechristened with the name of Brixment.

The extensive rock deposit at the new Brixment mill is covered with large volumes of overburden.

View from top of incline showing entrances to quarry.



Part of the Mill. Tops of Large Storage Silos May Be Seen. View Showing One of Gas Kilns—Incline from the Quarry in the Background.

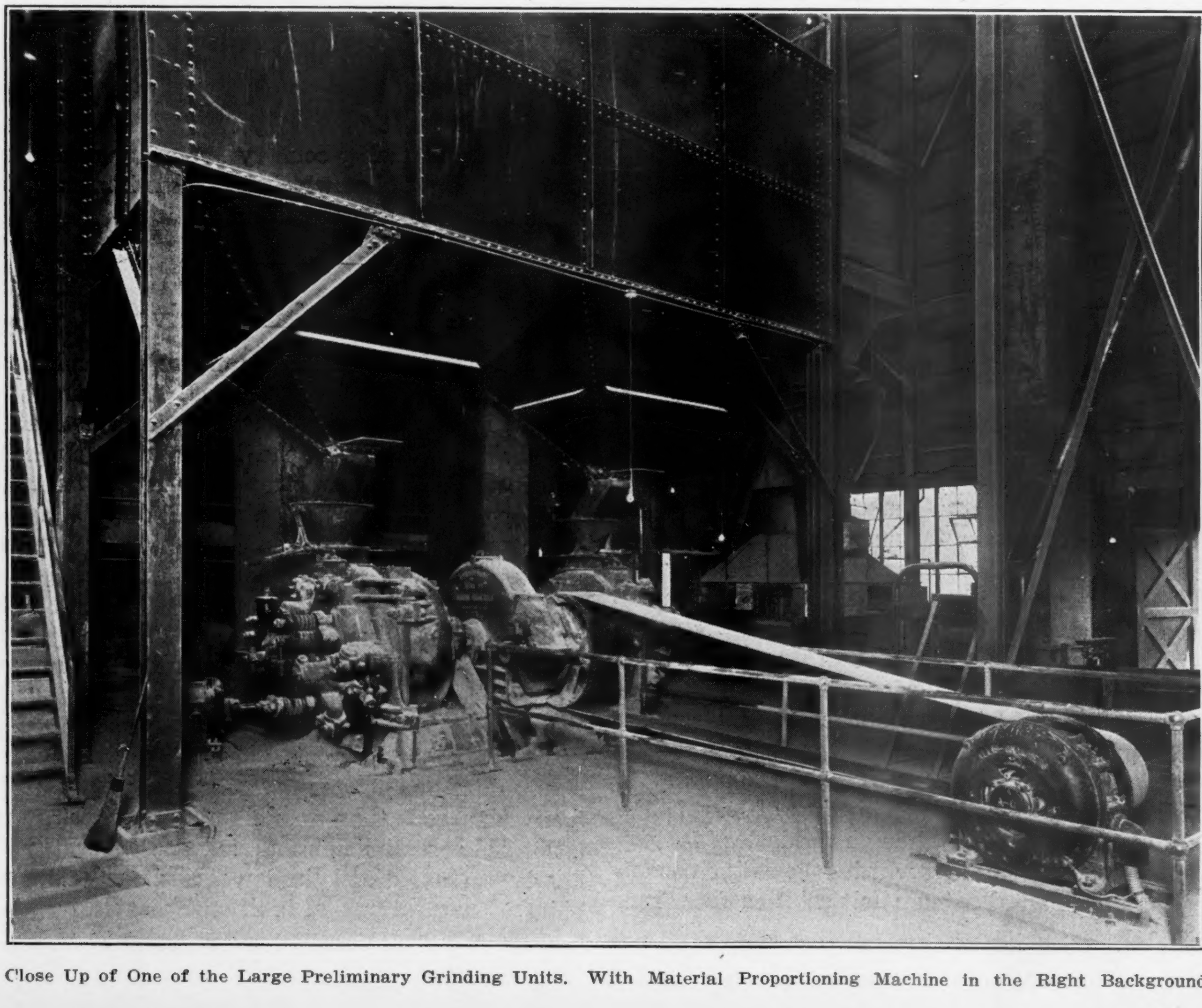
View of Large Steel Tanks Where Brixment is Treated to Make it Extremely Plastic.

To insure absolute purity in the finished product it was decided to mine the rock through the hillside. So the mining operations were commenced, the mine was beamed, lighted and ventilated, and a narrow-gauge railroad constructed for carrying the hand-picked rock to the huge steel bunkers for storage. It is a well known fact that Brixment is ideally adapted to winter use—another reason for the mining of the rock, permitting uninterrupted production throughout the winter months, was decided upon.

From the huge storage bunkers the rock is conveyed to the top of a vertical kiln by three ton-capacity skip hoists having automatic cycles of operation. This kiln, measuring seventy-five feet in height and twenty feet in diameter, lined with nine inches of Sil-o-cel and eighteen inches of fire brick, is the only one of its kind for burning cement rock in the United States. To insure absolute evenness of burn and to prevent all possibilities of discoloration that might be caused by other fuels, the heat used for calcining is produced by large gas producers located on opposite sides of each kiln. In this way operators in charge have perfect control of the heat at all times and the continuous draw of the kiln can be slowed or speeded as the operator wishes.

Before being crushed and ground, the burned material from the kilns is allowed to cool. It is then passed through Sturtevant rotary crushers and a Sturtevant duplex ring roll. The final pulverization takes place in large tube mills where the future Brixment is ground so that 85 per cent of it will pass through a 200-mesh sieve. After being ground to this unusual fineness in the tube mills the material is forced by Fuller-Kinyon pumps into large concrete storage silos and there held for bagging. High-setting Bates packing machines uniformly pack the bags of Brixment, which are then carried by a belt conveyor to the cars, ready for shipping.

Months of careful planning were consumed before any of the new mill's equipment was specified. The electric motors are either of the slip ring or synchronous type. In addition to the regular mill buildings, the new Brixment plant includes modern machine, forge and sheet metal shops. A complete laboratory in charge of competent chemists is also maintained for conducting at frequent intervals both chemical and physical tests. Despite the present large capacity of the new Brixment mill, it is apparent that the manufacturers are anticipating increasing the capacity of the new mill, for all buildings have been constructed on the unit basis to allow any amount of further expansion.



Close Up of One of the Large Preliminary Grinding Units. With Material Proportioning Machine in the Right Background.

NEW ALUMINA PRODUCTION PROCESS

By Heinrich Kassler*

IN CONNECTION with Dr. W. Mehnert's article (Chemiker Zeitung, 1926, p. 657) on "The Raw Material Problem in the Aluminum Industry," I take occasion to report on a new process which will make the aluminum industry independent of bauxite. Several months ago a patent was granted to Otto Lederer and Dr. Walther Stanszak (Czecho-slovakian Patent 18648) according to which it is possible starting with clay, kaolin, loam and other difficultly decomposable silicates to obtain solutions of aluminum salts with an almost theoretical yield whilst previous processes gave only a very limited yield. According to the process described the clay is treated with soda solution under pressure and is allowed to cool under pressure. The alumina which because of its chemical form remains practically unchanged is then filtered off and treated with acids to obtain it in solution. Aluminum sulfate and iron sulfate, for instance, are obtained in solution and the soda is sent back into the cycle of operations with only small losses. The process results in bringing practically the complete alumina content of the clay into solution. The mechanism of the process is shown as follows: On heating the clay with the caustic soda solution it reacts to form sodium aluminum silicates and carbon dioxide (gas) thus:

$$Al_2O_3.\ 2SiO_2.\ 2H_2O + Na_2CO_3 = Na_2O.\ Al_2O_3.\ 2SiO_2 + CO_2 + 2H_2O.$$

But this reaction is reversible. On cooling in the closed vessel the carbon dioxide reacts with the sodium aluminum silicates and produces alumina and silica which age very rapidly at the high temperature and become practically insoluble in the soda solution. On analyzing the filtered off soda solution it is always found to contain bicarbonate which results from the action, on cooling, of the carbon dioxide on excess soda solution. This undesirable secondary reaction which uses up carbon dioxide required for the re-formation of alumina instead of bicarbonate is limited to the greatest possible extent by the maintenance of specified conditions. This is so far successful that the soda content of the residue does not exceed a few per cent. The soda which removes organic substances from the clay and gradually becomes richer in these substances in the course of operations must be taken out of the cycle after a certain number of operations and calcined to render it usable again in the process.

The advantage of this process as compared to other processes for the solubilizing of clay is the high yield of alumina while the soda loss is very low. The acid treatment which follows the decomposition gives an aluminum salt solution free from silicic acid which is not possible in any alkaline process. In addition owing to the practically complete extraction of the iron and alumina there remains an almost perfectly pure amorphous silicic acid which has many possible uses.

The working up of the solutions obtained (aluminum and iron sulfates, for instance) is carried out according to a process for which application for a patent is being made by Otto Lederer, Dr. Walther Stanczak and Heinrich Kassler. It makes it possible by direct precipitation with ammonia in a simple manner to obtain alumina with less than 0.1% of iron oxide. The details of this process cannot be published at present. The advantage here is that ammonium sulfate is obtained as a by-product containing a large part of the potash content of the clay and it is thus valuable as a mixed fertilizer.

In the immediate future a factory is to be erected in Czecho-Slovakia which will operate on this process. It will serve not only to produce alumina and salts of aluminum but will have as a primary object the accumulation of operating data on the process. The plant is the "Aluminiumhutte, Chemische Fabrik, Schlik and Co." of Kostelec n/Orl., Czecho-Slovakian Republic.

Regarding the economic importance of the process the article of Dr. Mehnert need only be mentioned; he reflects distinctly the anxieties of every aluminum producing country not owning sufficient bauxite deposits but which possesses immense clay deposits not heretofore utilized.

*From Chemiker Zeitung, Dec. 4, 1926.

Safety of Explosives

To the end that yet safer explosives and blasting methods may be developed, the Bureau of Mines, Department of Commerce, is investigating the factors which affect the liability of an explosive to cause ignition of gas or coal dust. The effect of chemical composition, physical characteristics, and explosive properties of the explosives themselves, as well as the methods of loading them in the borehole, are being investigated in a testing gallery from this point of view. It has been shown that for explosives of identical chemical composition, those having higher rates of detonation are more likely to ignite gas. Wet fireclay stemming or fine rock dust stemming are safer than dry fireclay. Coal dust stemming has been shown to be more dangerous than no stemming at all. The relation between limit charge and gas concentration has been studied and the lower limit of inflammability of natural gas to ignition by explosives has been determined.

COMMERCIAL SIZES OF BROKEN STONE

By F. H. Jackson

Engineer of Tests, U. S. Bureau of Public Roads*

PRACTICALLY every one having to do with either the production or the utilization of crushed stone will concede at least the theoretical advantages which may be derived from the standardization of sizes. The wide divergence of existing standards of construction, however, coupled with a natural reluctance on the part of engineers to change their practice simply to comply with a national standard, has made progress in this field very slow. We all know of course how the unsystematic development of the various types of bituminous macadam and bituminous constructed roads has resulted in a demand for a great number of sizes of stone, for a comparatively small number of distinct types of construction, the variations often being of academic rather than practical significance.

We may classify these variations in requirements in two ways, first those due to distinct differences in engineering practice for a given type of construction and second, those very small differences in requirements which are in reality meaningless, but which frequently cause lots of trouble. As an illustration of the first class, a survey of twenty-seven current state specifications for penetration bituminous macadam reveal that there are now specified as many as ten different sizes of stone for use in the penetration course alone, varying all the way from a 1 inch to 2 inch size to a 2½ inch to 3½ inch size. As an illustration of the second class, we may take the requirements for size of chips for bituminous macadam, where a current specification shows an inexcusable number of slight variations in size, as for instance, 3/16 inch to 5/16 inch, ¼ inch to ½ inch, 5/16 inch to ½ inch, etc.

Making every allowance for variations in size necessitated by difference in quality, it is yet obvious that the multiplicity of requirements in force is not only unnecessary and confusing but also works a hardship on the producer, increases the cost of production, and so tends to ultimately increase prices. On the other hand, we must remember that it is the engineer in charge of construction and not the producer of the material who is responsible for the quality of the work and for this reason we cannot expect him to abandon a size with which he has perhaps had many years satisfactory experience unless we can convince him that the standard size will prove just as satisfactory. And herein lies our greatest difficulty. It is not, I believe, as much with the producers as with the engineers. My experience with the producers in general is that they are more than willing to supply what the engineers want, provided the latter will only agree as to just what they do want.

The Road Material Committee of the American Society for Testing Materials, through its Sectional Committee on Standard Sizes of Broken Stone, Broken Slag and Gravel, of which I happen to be Chairman, has, as many of you know, been struggling with this problem for a number of years and as a result of its efforts, has prepared Tentative Specifications for Commercial Sizes of Broken Stone. These tentative specifications were prepared after an exhaustive study of existing specifications with a view to the selection of the minimum number of primary sizes of crushed stone which would supply the engineers' legitimate needs and at the same time eliminate the many small variations in requirements which had not justification other than that they represented the ideas of individual engineers or groups of engineers. This was, as may be supposed, no easy task, because it involved not only the elimination of many sizes for which the Committee felt standard sizes could be substituted but also because it necessitated a careful study of the various factors which influence the efficiency of plant screening operations in order that the size limits and tolerances specified might be practical from the standpoint of economical production. It is the careful balancing of these practical limitations against theoretical requirements that constitutes our problem.

Before proceeding to a discussion of the proposed standard, it may be of interest to review very briefly the results secured from a rather extensive survey of crushed stone plants made by the Bureau of Public Roads several years ago. The survey included over 100 representative commercial stone crushing plants situated in the New England, Middle Atlantic and Ohio Valley States. The information secured, while of course centering about the screening operation, included data relative to crushers, their number, type and size, speed and arrangement of conveyors, etc. The screen data included the number, type and arrangement of screens, the nominal as well as actual size of perforations, the length, diameter, pitch, and speed of revolving screens, together with the number and length of each section, arrangement of jackets, etc. A record was also made of each commercial size produced by the plant with the screen installation as indicated at the time of inspection. This record included the nominal size limits for each product, the name and number under which it was sold,

*Presented before the Tenth Annual Convention of the National Crushed Stone Association, January 19, 1927.

the specifications it was supposed to meet. Finally, a representative sample of each size was secured from a stock ready for delivery and a screen analysis made with the laboratory screens using circular openings.

From the data secured as outlined above, it was possible to determine directly the efficiency of each screening operation at the time of inspection in so far as it was affected by the screens themselves. Other factors which affect screening efficiency, such as fluctuations of the feeding rate, and moisture on the stone were noted and their effect on the particular material selected for sampling determined as nearly as possible. It may be of interest to briefly summarize the conclusions which it was possible to draw from this survey, and they may be stated as follows:

1. The length of a revolving screen influences the grading of the screened product to a marked degree.

2. Within the relatively narrow limits usually found in plant installation, pitch and speed of revolving screens have no practical influence on grading, probably on account of other predominating factors, such as fluctuations in the rate of feed of stone to the screen, which it is impossible, practically to control.

3. The effect of oversize holes due to wear of the screen is practically negligible in view of the relatively large amount of stone held on a revolving screen which theoretically should have passed through it.

4. Small amounts of oversize stone, sometimes found in products screened through holes of certain nominal diameter, usually are due to faulty bin or chute construction, lack of repair, or other deficiencies in the storing or handling of the material.

5. The grading of the screened product can not be controlled with any degree of certainty by simply specifying the size of openings in the revolving screens over which and through which it shall pass.

6. It is neither practical nor necessary to specify that all material retained on and passing revolving screens of certain sizes shall lie between laboratory screens of the same size.

7. By the insertion of a reasonable tolerance, that is, one wide enough to cover the recognized inefficiency of the revolving screen, and yet close enough to insure sufficiently well graded materials, the laboratory screen may be used logically to control the grading of the plant product.

8. Inspection of the results of hundreds of screen analyses indicate that as much as five per cent material should be allowed larger than the size of perforations in the revolving screen through which the product is supposed to pass, and as much as fifteen per cent generally should be allowed smaller than the size of the perforations in the revolving screen upon which it is supposed to be retained. The last conclusion applies of course only in the case of products sized with revolving screens and presupposes an adequately designed plant and efficient operation. It applies also to the so-called primary sizes only, that is, those sizes where the upper and lower limit are close together; say ¾-1¼ inches. On combined sizes, such as are used as concrete aggregate, ¼-2½ inches, for example, the tolerance on the lower limit may and should be materially reduced.

With regard to the method of specifying the sizes desired, there are still many engineers who believe that it is necessary to tell the producer just what plant screens to install in order to obtain the sizes they desire. In my judgment, the operator of the average commercial plant, is in a much better position to decide on the particular screen installation he needs than is the engineer, whose province, as I see it, is to specify the size or sizes desired in such a manner as to admit of but one interpretation; that is, by the use of laboratory screens. With the specification in hand, it then becomes the operator's duty to study his installation so as to produce the material in the most efficient manner. Viewed from this angle, the object of the 15 and 5 per cent tolerances just mentioned is simply to recognize the practical limitations beyond which it is impossible to carry efficient operation without greatly increasing the cost.

The facts which were brought out by the survey were of course available for the use of the Committee on Standard Sizes of the American Society for Testing Materials, and form the principal basis of the Committee's recommendations as regards tolerances, etc., in their proposed specification which, with your permission, I shall now discuss:

As stated above, the Committee was, at the outset, confronted with the necessity of reducing the number of primary sizes to a minimum consistent with sound engineering practice. Moreover, it was recognized that the limits of the various primary sizes should not overlap, and when taken together should represent the entire output of the plant. It was also felt that if possible the number of primary separations should be limited to five, due to the greatly increased cost of producing more than five primary sizes in one plant at one time. It is interesting to note in this connection that many large producers replying to a recent invitation from the National Crushed Stone Association to criticize the proposed standard, stated that from the standpoint of economic production, the number of primary sizes should be limited to five.

The Committee also considered very carefully the question of nomenclature. That was the simplest and most easily understood method of designating sizes. At present as you all know there are many systems in use, to the utter confusion of everyone. We have number 3 stone, we have 1 inch stone and we have Pea stone, to mention three methods of designating sizes. But what is worse, these designations do not mean the same thing in different localities. What is No. 1 stone in one state may be No. 3 stone in an adjoining state. What does the purchaser mean when he asks for a car of 1 inch stone? Does he mean a maximum size of 1 inch or an average size of 1 inch and if so what are his upper and lower limiting sizes? Our Committee after carefully considering the various systems in current use, decided that the simplest as well as most definite method of designation would be to specify both the upper and lower limiting sizes, as for instance: ¼ inch to ¾ inch size, ¾ inch to 1¼ inch size, etc., which together with a standardized schedule of tolerances, intermediate requirements, etc., would give a perfectly clear understandable designation, provided—and here is the rock upon which all of our past efforts have been wrecked — we commonly agree among ourselves upon some standard method of measuring size. Shall we use sieves with square openings, or screens with round openings? It is a problem which belongs to the Testing Engineer and is one which I am ashamed to say he seems to be about as far from solving as he was ten years ago, due to the apparent impossibility of reconciling the conflicting opinions of the concrete people, who favor the square mesh on account of its application in the design of Concrete by the Fineness Modulus Method, and the Bituminous people who favor the round hole because it has been used since time immemorial for measuring the size of crushed stone for Bituminous work, and in general is considered a more accurate measure of size than the square opening. However, the Committee on Road Materials of the A. S. T. M. which contains representatives of both interests, last year went on record as favoring the round aperture and on the basis of this the sectional Committee on Standard Sizes decided to submit its tentative schedule of sizes with this method of measuring as the basis. In other words, when we say ¼ inch to ¾ inch size, we mean that portion of the product of the crusher at least 85 per cent of which will be retained upon a laboratory screen having circular openings ¾ inch in diameter and not more than 57 per cent of which will be retained upon a laboratory screen with circular openings ¾ inch in diameter.

On the basis of five primary sizes as the maximum limit and after carefully studying existing specifications, the Committee proposed the following divisions of the crusher run from 0 to 3½ inches:

0 —¼
¼—¾
¾—1¼
1¼—2½
2½—3½

the separations to be on the basis of laboratory screens with round openings. Assuming, in general, that stone will crush in such a way that the percentage of the total crusher run passing any particular size screen will be proportional to the size of the opening—that is, conforming to what is known as a straight line grading, then the relative percentages of the total crusher run obtained in each of the five primary sizes would be about as follows:

0 — ¼—10%
¼— ¾—15%
¾—1¼—15%
1¼—2½—35%
2½—3½—25%

The relative percentages of the various products will of course vary in individual cases with the type of stone, type of crushers and amount of recrushing. For general conditions, however, and assuming the rejects above 3½ inches recrushed, the above may be considered an indication of average results. It is interesting to note that Mr. Sanborn in quite an elaborate plant test, the results of which were published in the July issue of the "Crushed Stone Journal," arrived at substantially the same conclusion.

It will be of interest now to study the above system of sizes with a view to ascertaining to just what extent each is available to the engineer and how they may be combined, always remembering that for each primary size a tolerance of 15% is allowed on the lower limit and a tolerance of 5% on the upper limit. The problem of establishing standard size limits so as to care for the entire output of all the plants with a minimum of waste at all times is of course a hopeless one, due to uncontrollable fluctuations in the demand, which may cause a certain size to be in great demand, one month and a drug on the market the next, as well as to difference in the demand for stone of different kinds, as for instance, limestone, where the supply of road material and concrete aggregate sizes may be greatly affected by the demand for flux stone or agricultural limestone compared to trap rock when no such demand exists. Because of these facts, it is obviously impossible to carry standardization to the degree where a uniform standard of plant practice is possible. Every plant, every producing district has its own peculiar problems and the best that standardization can do is to provide a common measure for the use of the engineer in making known his needs to the producer so that the latter will know exactly what the former wants and the former will know exactly what the latter has to offer.

Turning now for a moment to a discussion of the uses to which the several suggested sizes may be put, we will consider the material over ¼ inch in size and the first fraction thereof—namely, the ¼-¾ inch size. This is commercial half-inch stone very largely used in road work both as chips in bituminous macadam by the penetration method, in certain grades of bituminous concrete and as a surface dressing, and in maintenance work. We felt that a tolerance of 15 per cent on the ¼ inch while giving us a reasonably well sized product, was still liberal enough for economic production. The next size, ¾-1¼ inch, is commercial 1 inch stone, with the same tolerance, 15 per cent. It may be used alone as the intermediate course in bituminous macadam, or in combination with the ¼-¾ inch size in certain grades of bituminous concrete or as an aggregate in Portland cement concrete, where the maximum size must not exceed 1¼ inch. The combination size, assuming it is made up of ¼-¾ inch size and the ¾-1¼ inch size, each of which complies with specifications for that size, may reasonably carry a somewhat lower tolerance than 15-10 per cent at least and possibly 5 per cent in the case of concrete aggregate, where a relatively large percentage of the ¾-1¼ inch size should be used in the mixture. The next size 1¼-2½ inch, is proposed for use in macadam road construction, either penetration or waterbound. Objection has been raised to this size for penetration macadam on the ground that a larger size product, say 2 to 3 inches would give better results and that the maximum size stone should only be limited by the depth of the course. Reviewing the several state highway department specifications, we find a wide divergence of practise. Out of twenty-seven state specification standards we find three with a maximum size of 2 inches, twelve with a maximum of 2½ inches, seven with a maximum of 2¾ inches, five with a maximum of 3 inches, and one with a maximum of 3½ inches, the latter to be used only in courses exceeding three inches in depth. Here we have an illustration of the wide divergence of current practice and the practical impossibility of pleasing everybody. Some one may ask "Why not compromise by raising the upper limit to 3 inches?" without realizing that to do so would throw the entire specification out of balance by eliminating 2½ inches separation which is insisted upon by the users of concrete aggregates. At the present time the Committee is inclined to adhere to the present limit of 2½ inches for bituminous macadam where the course is less than 3 inches in depth and to suggest the 2½ to 3½ inches size where the course is greater than 3 inches in depth.

We now have three primary sizes which together represent the run of the crusher from ¼ to 2½ inches. When properly combined these three sizes may be used to produce an ideally graded aggregate for concrete for pavements where the maximum size is 2½ inches. Just what constitutes an ideal grading for coarse aggregate for pavements makes an interesting problem for discussion, both from an economic and an engineering standpoint. Quite recent investigations made by the Bureau of Public Roads in cooperation with the New Jersey State Highway Commission indicated that the yield of concrete from given volumes of the constituent materials was greatly influenced by the grading of the coarse aggregate. As an illustration, it was found that in the case of a 1:1¾:3½ mix, using crushed trap rock as coarse aggregate, an aggregate graded uniformly from 2½ to ¼ inches in size required 6.18 bags of cement per cubic yard of finished concrete as compared to 6.72 bags required when the material under 1 inch in size was omitted, a saving in cement of about ½ bag per yard. It is true that a considerably greater weight of stone was required in the case of the well graded aggregate than in the case of the poorly graded material, so that from a strictly economic point of view the gain in cement would be somewhat offset by the additional stone required. The economic aspects of concrete proportioning have not received the attention that they should.

If we assume for the moment that the ideal grading curve for stone between ¼ and 2½ inches in size is approximately a straight line, which according to Taylor and Thompson, is the condition of maximum density, it would be necessary to mix our three commercial sizes in approximately the following proportions:

1¼-2½	inch	size	—60%
¾-1¼	"	"	—25%
¼- ¾	"	"	—15%

This, it will be observed, is very nearly the ratio in which these sizes are produced in the normal crushing process, and would therefore, be the most economical way for the producer to ship, provided he did not have a heavy demand for ¼-¾ inch size which is often the case. However, the point to be emphasized here, I believe, is that in concrete work it is highly important to have a uniform grading of coarse aggregate from day to day if satisfactory results are to be obtained. This rule holds irrespective of the method used in designing the mix. As a matter of fact it is even more important, viewed in the light of some of the new theories of concrete design which have been advanced, due principally to the effect of variations in gradation on the workability of the concrete and consequently on the amount of water which must be used in order to properly place the concrete in turn will, as we all know, affect the strength of the concrete, resulting in a non-uniform product. While on this matter, I wish to impress upon you again the great importance of maintaining uniformity in the gradation of aggregates for concrete, even though the specification may allow a considerable variation in some of the intermediate sizes. Rigid attention to such detail will, in my opinion, do more towards overcoming the natural disadvantages of crushed rock as compared to certain other aggregates than will any other one thing and will at the same time insure better concrete.

The remaining size in our crusher run is from 2½ to 3½ inches and would be available for use either as base course in waterbound or as bituminous macadam for courses over 3 inches in depth. In times of heavy demand for the smaller sizes, this size could of course be recrushed as desired.

The original tentative standard specifications of the American Society for Testing Materials have been amended once by the insertion of a 0-½ inch size to provide for stone for Topeka type pavement. Many additional changes have been suggested both voluntarily and in response to inquiries sent out by the committee. Among them is a request for a commercial ¾ inch stone, from ½ to 1 inch in size for use in tar macadam. The sponsors for this size claim that the ¾ to 1¼ inch size is too large for intermediate size stone in bituminous macadam. Here again we have conflict of engineering opinion operating against the adoption of a rational standard, because it can readily be seen that the ½-1 inch size has no place in the system of size as above outlined.

Very strong representation has also been made by certain eastern groups that a ⅝ inch limiting size be substituted for the ¾ inch. This size is very largely used in the East now as the lower limiting nominal size for cement, concrete, aggregate, and there certainly seems some merit to the contention that with the ¼ inch lower limit, there is danger of obtaining too high a percentage of small size stone which, as any one knows, makes a very harsh concrete, difficult to finish properly. The above illustrations are given simply to show that the problem has by no means been solved and will require a great deal more work on the part of intelligent, sympathetic representatives of both the producing and the consuming interests before it is solved.

It should not, however, be assumed that no progress has been made since this matter first came up for discussion. It will be of interest to note that the sizes as proposed have been adopted as tentative by the American Association of State Highway Officials, the Federal Specification Board and the Asphalt Association. It will be seen therefore that the specifications have advanced considerably beyond the initial stage. These, however, with the exception of the Federal Specifications are in the nature of typical rather than governing specifications and are in no sense mandatory.

In conclusion, there seems to me to be three courses which may be followed towards the ultimate solution of this vexing question. We may (1) work for the standardization of the suggested series of sizes, or failing that (2) suggest other sizes which may be substituted therefore, or failing that to (3) abandon all idea of adopting a national standard, acknowledging that the question of the actual sizes to be used is a problem for each producing district to work out in conjunction with the consumers which it serves.

Government Actually Starts Drilling Potash Wells

A contract for drilling a test well in Eddy County, in southeastern New Mexico, for potash exploration purposes, has been awarded to the Sullivan Machinery Company, by Scott Turner, Director of the Bureau of Mines, with the approval of the Secretary of Commerce. The bid submitted by this company was the lowest of four bids received. The company will immediately move equipment to the site designated, and it is anticipated that drilling operations will begin within about three weeks.

This action will mark the beginning of the actual drilling campaign under the supervision of the Federal Government in the effort to obtain ample domestic potash supplies. The site on which the test well is to be driled is located on public lands of the United States, and is therefore not subject to restrictions in the enabling act which require the negotiation of leases with all owners of land or mineral rights within a radius of one mile of any proposed test hole. The site is in NW. ¼ of Section 13, Township 17S, Range 31E, approximately 35 miles east of Artesia, New Mexico, and is within the area recently announced by the United States Geological Survey as holding great promise for the discovery of commercial potash beds. The site is approximately 20 miles distant from the McNutt test well, recently drilled by private interests, cores from which demonstrated the existence of ten groups of beds containing potash-bearing salts of possible commercial interest. Cuttings from a number of oil wells drilled in the vicinity have also indicated the existence of potash beds.

The New Mexico drilling site is the fifth site recommended to the Bureau of Mines by the Geological Survey as being favorable for potash exploration purposes. The other four sites, located in central western Texas, are affected by the restrictive clause of the enabling act requiring the negotiation of leases with owners of land and mineral rights. In the progress of drilling the test well, a complete core will be taken from top to bottem. It is anticipated that the top of the potash-bearing salts will be reached at a depth of about 850 feet. The total depth recommended for drilling is 2,000 feet, which may be shortened to 1,850 feet or extended to 2,300 feet, depending upon developments. The cores obtained will be turned over to the Geological Survey for study and analysis.

Bills modifying the terms of the potash enabling act, by eliminating the requirement of obtaining leases from all owners of land and mineral rights, have been introduced in the Senate and the House of Representatives. It is thought that passage of these bills will facilitate the drilling of test wells on favorable sites previously designated in Texas.

SAND AND GRAVEL IN ASPHALT PAVEMENTS

By F. C. Field

Chemist, Asphalt Association*

THE National Sand and Gravel Association and the Asphalt Association have a mutual interest in the use of sand and gravel and asphalt in highway construction because of a certain interdependence for material. The gravel in roads is of very early origin. At present probably in excess of 100,000 miles of such roads are in use in the United States. Such roads undoubtedly met a requirement in the early stages of the improvement of the highway. The constant growth of traffic on our highways brings to many of these roads a density of traffic beyond the limitations of this type of construction. It then becomes necessary to resort to some bituminous binder such as road oil. With further increase in traffic density, a still higher type of wearing course is required to resist the destructive effect of traffic. The use of asphalting concrete gives full value to the gravel base.

This is a sound business policy in highway construction. Gravel roads are now constructed in many localities and the permanent value of the foundation is recognized. The old feather-edge is discarded and the road is trenched on the side and gravel-filled, adding materially to the permanent value of the road foundation. In such construction the employment of asphaltic concrete and surfacing material has a very distinct advantage, in that it does not interrupt traffic on such roads. After a road has been carrying traffic to the extent that gravel will not withstand the wear, it is of considerable importance that this amount of traffic be not interrupted in improving the road surface.

Asphalt is employed to the extent of over one and one-half million tons per year of road construction. Some of your members who do not produce asphalt sand do not realize that the sand employed in asphalt pavements is over 10,000,000 tons for a year. The quantity of gravel used is difficult to estimate. Sand is used in practically all fine aggregate asphalt paving measures. Specifications for paving materials recommended by the Asphalt Association permit the use of uncrushed gravel in all types of asphalt pavement except asphaltic macadam, and of course, excepting the fine aggregate mixture. The interlocking of angular, broken stones is essential in the asphalt macadam. In all mixtures such as asphalt and concrete, black face gravel aggregate it has been learned may be used, because stability can be made by packing the gravel with fine material. Many engineers prefer the gravel aggregate for such pavements. That pavements constructed by this method do successfully bear heavy traffic has been learned by the long service given.

Extensive research is being conducted on paving material. The Asphalt Association Laboratory and other workings along this line find much evidence that it will not mean the elimination of specification, but it will probably result in a considerable lessening of certain of the troubles now experienced by the producers. In many instances at least, it may mean the stopping of the present practice of mixing sands from several sources, in an effort to produce a specified rate. A reasonable control in handling sand to maintain uniformity will be necessary. The changing of specifications in this line will be gradual. The available material for a given locality will likely form the basis of those specifications.

Now, an alteration of the grading of this sand, if it isn't too rapid, can readily be taken care of in asphalt mixtures by altering the character or quantity of the asphalt and the filler, so sands that in the past have been rejected because of not meeting a standard grading can in many localities be employed with equal success to the best ends. It will be necessary, however, to make a very careful study of the sands in certain of the localities on the basis of the new ideas of requirements for grading and proportion of sizes.

*Presented before the Eleventh Annual Convention, National Sand and Gravel Association, January 19, 1927.

More Potash Found in Texas, New Mexico

Although the government has appropriated money for core drilling in the potash field of Texas and New Mexico to increase its knowledge of the extent of the field and of the presence and depth of the potash-bearing beds it must still in large measure be dependent upon oil wells for such information. The department of the interior announces through the geological survey that potash has been found in 26 additional wells, distributed in eight counties in Texas and three counties in New Mexico. Reagan County, Texas, contains 8 of the wells, Upton County 5, Crockett County 4, Eddy County, New Mexico, 2, and Crane, Irion, Pecos and Ward counties in Texas, and Chaves and Lea counties in New Mexico, 1 each. There are now about 70 wells in 18 counties of Texas and 6 wells in 3 counties of New Mexico that have furnished potash-bearing samples that have been analyzed by the Geological Survey. Indications of potash have been found in the E. C. Slaughter No. 1 well, in Martin County, Texas, but the analysis of samples from this well has not been completed.

MARKETING AGSTONE IN ILLINOIS

By J. R. Bent

Director, Farm Supply Department, Illinois Agricultural Association*

BUSINESS today is confronted with many natural or inherent difficulties but these are multiplied many fold by lack of understanding and misunderstandings growing out of the failure of men and groups to become better acquainted and appreciate each the other's needs and limitation. I feel that you who engaged in the extraction business of limestone quarrying, with agricultural limestone one of your products, and I who am employed as a representative of the farmers' interests, are striving toward the same goal although we approach it from different angles. In other words, I feel that agricultural limestone is a common meeting point for the quarrying industry and for the agricultural industry.

Agriculture is the foundation of national welfare; soil fertility is the foundation of agricultural welfare; limestone is the foundation of soil fertility. You, therefore, are of first importance, representing an industry fundamental to our national life. Justice Von Liebig, the great German scientist and philosopher, who lived between the years of 1803 and 1873, asserted as a fact that the rise and fall of the empires and the nations of the world have borne direct and vital relationship to the degree in which these nations have maintained soil fertility and efficient agricultural production. Dr. Van Hise, late president of the University of Wisconsin, although himself a noted geologist rather than an agronomist, at one time wrote: "The surface layer of soil manufactured by the processes of nature through millions of years, is the most precious resource of the nation. Of all our duties to our descendents, that of maintaining the soil unimpaired in thickness and in richness is the most serious."

No nation in the history of the world has ever possessed a greater asset than has America possessed in the fertility of her virgin soils. No nation in the history of the world has ever more extravagantly used, wasted and abused its natural resources than has America. No natural resource has suffered more in this respect than has soil fertility. The American farmer is sometimes referred to as the most efficient farmer in the world. I feel that the word "effective" might better be substituted for the word efficient. By means of mechanical farming with labor saving machinery, coupled with the natural fertility of the soil, he has been able to produce more per man per year; but the average American farmer has done this at the expense of the soil. While there were new lands waiting to be settled, the tendency was to disregard the importance of maintaining the productive ability of the older lands. The new lands are now practically gone.

Many American farm families have lived by the gradual liquidation of their chief capital asset, soil fertility, which they have hauled to market in some other form, such as livestock, grain, hay, dairy or poultry products, etc. Some have finally sold their farms and have retired on the unearned increment, reflected in the advanced sale price per acre, even though the real asset, the reserve productivity of the soil, is less than when the farms were first acquired.

Right here let me say that I feel that the farmers as a class should not be held responsible for a fault which is national in character. The conditions which surround agriculture today are the product of a complicated industrial and commercial system in which agriculture is out of joint. While it is true that the extravagant and wasteful manner of handling the soil in our agricultural system is a national problem which needs a national solution, it is also true that the individual farmer can receive a commensurate reward if he adopts crop rotation methods suitable to his territory and applies, correctly, soil building and maintaining materials. At the University of Illinois are some field plots where careful experiments have been carried on for a long period of years. As an example, based upon average values and practical farm conditions, on plots where corn has been grown continuously, without crop rotation or soil treatment, the cost of production per bushel has arisen to 93 cents. On plots where a rotation has been used, including clover, the cost to produce corn per bushel has been held to 52 cents, and on plots where the crops have been rotated and manure, limestone and rock phosphate have been added, the cost of corn has been reduced to 43 cents per bushel, and these last figures include the cost of treatment.

Limestone in Southern Illinois applied at the rate of two tons each four years on a test field doubled the yield per acre. The value of the increase in the four year period nearly equalled the original purchase price of the land. Former Governor Lowden of Illinois is another great leader who has recognized the importance of this problem. A year ago he said, "We have been marketing not alone the annual yield of our lands, but we have been selling with a prodigal hand its fertility as well. There is no more important question before the American people than a national agrarian policy, which will restore and preserve the fertility of our soils. The first principle in this policy is that agriculture must be made profitable. The great

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agricultural plant has been running down for many years, but never so rapidly as during the last five years of relatively low prices for farm products. Sooner or later that deterioration will result in higher prices for food."

Cropping is not the only agency which depletes the calcium and magnesium of the soil. Extensive experiments conducted by the Kentucky Experiment Station, in which the waters of the Mississippi River were analyzed at frequent intervals and coordinated with the gallonage flow at the same intervals and the total area in the Mississippi drainage shed indicated that the average loss through leaching is from 200 to 500 pounds per acre per year. Some one has converted this into terms for my own state of Illinois, and while I have not checked the figures, they are said to represent a loss through leaching of 2,170 trainloads of limestone, or one train 600 miles long. Such figures are hardly comprehensible. They indicate the size and seriousness of the problem in which your industry must contribute most materially toward the solution. They indicate that despite the gratifying increase in the use of limestone which most of the mid-west states have experienced, we are not actually gaining but are actually losing in the major problem of the maintenance of soil fertility.

The practice of applying some form of lime to the soil and some knowledge of its benefits are nearly as old as agriculture itself but clear down to comparatively recent times mechanical reduction of limestone was not an economic possibility and the only practical way in which lime could be applied to the soil (other than as marl or chalk) was in the caustic or burned form. This necessitated relatively small and frequent applications and in most of the agricultural regions such a practice became firmly established so that with the advent of pulverized limestone as a substitute for burnt lime, it was natural that material of early availability at relatively high unit cost and with small applications per acre should continue to be the practice.

Quickly available material, whether in the form of burnt lime, hydrated lime, air slacked lime or finely ground limestone, irrespective of its cost, would be inexpedient and uneconomic if applied in large quantities per acre. There would be what the chemist knows as mass action. In other words, the limestone would dominate the soil plant food balance and would interfere with, or inhibit, the availability of some of the other necessary plant foods, such as the phosphorous salts and perhaps the potash salts. There would be over-stimulation or liberation of some of the organic plant food elements and there would be heavy loss through leaching of these organic elements and of the lime itself. Logically, therefore, if highly available material is used the extreme theoretical ideal would be absurdly frequent applications in very small amounts.

Proponents of the use of coarser material say that there is a practical way to accomplish the same end and imitate nature in so doing. When nature constructed the most fertile soils of the earth she did so by the gradual disintegration of limestone deposits. We are imitating nature's process most nearly if we first bring our soils up to neutrality and then maintain them by some such stable method as the application of larger amounts of somewhat coarser stone, which will gradually disintegrate during a period of years, neutralizing soil acids as they develop and yielding calcium and magnesium as plant foods gradually as they are needed.

Three tons per acre of limestone screenings costing, freight included, perhaps two dollars per ton or six dollars per acre and containing as an average proposition perhaps 20 to 22 per cent or 1200 to 1400 pounds of material 80 mesh and finer, would be the equivalent in early availability of perhaps one and a half to one and three-quarters tons of more finely ground limestone containing approximately the same amount in pounds of 80 mesh and finer material and costing nearly as much. The former material would have the advantage of having graded sizes of coarser material still left in the soil to gradually yield through a longer period of time as a maintenance ration.

No hard and fast rule can be laid down on this controversial point and the speaker does not wish to be construed as posing as an authority from a scientific standpoint or as being hard boiled and arbitrary from the practical standpoint. Types of soil differ. Crops in various localities differ. Crop rotation practices differ. Conditions of the soil itself, irrespective of type, will differ. The need for quick response as a corrective measure will differ. Also the types of limestone used will differ widely both physically and chemically. Some forms of limestone are more soluble. Some are more porous than others and even the character of the porosity may differ. For instance some stones may have small pores which are inter-connecting. Such stones do not need so fine a pulverization in order to bring about sufficient surface contact with the soil solutions as do other stones equally porous but in which the pores are individual and not interconnected. Some stones are more friable than others. Such stones may contain incipient fractures as a result of the crushing and pulverized processes which cause them to go to pieces readily in the soil. Other stones are of dense, tough nature which resists such fracture.

There is great need for open-mindedness and flexibility in our specification policies in order that we may judge each case by itself and fit the conditions together in the most economic way. You, as a group, interested in limestone production problems are familiar with the production costs in the quarry and in the crushing and sizing plant, but are not so familiar with the scientific agricultural facts or with practical farm needs and technique.

Then we have the group scientists who have done immensely valuable work in studying the abstract problems of soil fertility and the plant food needs of our leading crops. There is great need for these two groups, industrial and agronomical, to be brought together on a cooperative basis to coordinate their information and needs into practical economy. Briefly stated, this has been the speaker's chief endeavor for the last seven years. He does not pose as a specialist in limestone production and quarry methods or as a specialist in agronomy, but he strives diligently to understand the languages of the quarrymen, the scientists, and the farmers and to translate each into practical terms for the other groups. Cost of production at your plants increases on an upward swinging curve as specifications may demand finer and finer grinding. On the other hand agronomical results in the soil (even if they are measured by early returns) increase on a gradually flattening curve. If these two curves can be coordinated or relatively superimposed from time to time, their intersection may be taken to represent the practical economic point under the current condition. In order to do this there must be constant contact on the one side with the continually changing scientific facts based upon different soil types, crop methods, farm technique, character of stones available for use, and, last but not least, the market conditions and prevailing prices for the various crops raised; and on the other side equal knowledge of the continually changing conditions, industrial and commercial, confronting the quarry companies. Some agency must take the lead in impartially coordinating these. The Illinois Agricultural Association has been trying to do this in its own state.

It has been suggested that you may be interested in a brief description of our Illinois relationships and policies. The speaker represents the Illinois Agricultural Association, which is the State Farm Bureau composed of 93 federated county farm bureaus with a total membership of some 60,000 or more leading and representative farmers. We have the most friendly cooperative relations with our state Agricultural College Experimental Station, and Extension Service. The College, Experiment Station and Extension Departments recognize their functions as being those of abstract research and teaching and we are more than content to leave these fields to them. They also recognize our field and we accept our function as that of applying the scientific findings and teachings of the research and extension agencies to practical everyday farming affairs. The Extension men cannot step out of their field to negotiate or deal with individual quarry operators, or with the quarrymen as a group. The farmer's practical business matters must be handled either by himself individually or through his own business organization.

We have striven not to make arbitrary, unintelligent demands upon the quarry industry, but rather to study with the latter the conditions under which agricultural limestone is produced and to work together for the elimination of factors which tend against economy in production and distribution; and to smooth out the road between the producer and the consumer.

We negotiate with the quarrymen the specifications for the material used in Illinois. In doing this we keep in mind constantly the advantage in helping the quarry operator to balance his operations and to have the farmers make use on their farms, so far as possible, that class of material which is of reasonably satisfactory quality for agricultural use but which has the least market demand otherwise. We try to avoid, so far as possible, specifications which necessitate items of extra handling and extra processing and which thus add to the production costs for which the farmer must in the end pay. We say frankly that in assisting the quarry industry in this way we expect to reciprocate by rewarding the farmer in the prices charged, the terms named and the service rendered.

There are some forty quarry companies located within Illinois, or close to its boundary in other states, which serve the Illinois farmer with agricultural limestone. Some twenty-five of these producing about 95 per cent of the total agricultural limestone used in Illinois are parties to an agreement with the Illinois Agricultural Association which recognizes farm bureau members with a discount of ten cents per ton in the price the latter pay for their limestone. This is not accomplished by maintaining two prices nor yet by making refunds, both of which have ethical and sentimental objections. Instead, shipments are billed at the same price to all, farm bureau members or nonmembers, but the farm bureau member can secure from his county farm bureau office a certificate stating that he is a member in good standing which entitles him to a discount of ten cents per ton when he remits for his purchase. His check, on the discounted basis, accompanied by the certificate on the ten cents per ton basis, together are accepted by the quarry operator as payment in full. This is justified by the fact that the farm bureau has been the greatest single factor which has developed the great demand for agricultural limestone in Illinois; and the bureau and its work have been made possible by the dues the member pays. The member is simply rewarded in kind for his part in the work.

The State Association provides a standardized form of order blank which in its comprehensive features is a material factor in eliminating error and misunderstanding; in promoting standard practices and in making statistical work easy. The original form goes to the quarry operator, the duplicate stays in the County Farm Bureau office, the triplicate goes to the ordering farmer as his own record of the transaction and the quadruplicate goes to the State Association office for statistical purposes. This entire plan has been a wonderful factor in rapidly developing the large demand for limestone in Illinois.

In 1918 Illinois used 200,000 tons of agricultural limestone. In 1920, a year which still felt the effect of the high point of agricultural prosperity, Illinois used 300,000 tons of agricultural limestone. In 1922 the tonnage dropped slightly, being 275,000 tons. In 1923 we began organized negotiations with the limestone producers. We got the new plan into effect in the following year, 1924, and that year showed a total consumption within the state of 500,000 tons. The following year, 1925, with the plan somewhat extended and improved, the tonnage went to 800,000. Last year, 1926, in all probability would have seen a further increase had it not been for the extremely bad weather conditions during the period when limestone is most heavily used in the corn belt area. The result was that the tonnage for last year probably did not exceed 650,000 tons.

The disposition in the future, I think, is going to be for a recuperation of last year's lost tonnage, and for further gains. To what extent this will be realized during 1927 will depend upon the farmers' financial status and even more particularly upon his financial state of mind. His losses last year and his present economic situation are the greatest inhibiting factors.

To summarize I would suggest that the following are the conditions upon which must rest the chances for the greatest development in the use of limestone on the soil.

1. Specifications established and varied from time to time in the light of intelligent knowledge of the economic conditions which currently prevail in the quarry industry and in the agricultural industry.
2. Efficient and adequate production at the quarries.
3. Reasonable profit to the limestone producer in order to keep up his interest and stimulate him to maintain quality and service as well as adequacy of supply.
4. Stability of price upon a basis fair to both the producer and the purchaser.
5. The promotion of the simplest, most direct, and most efficient system of sales and distribution.
6. Encouragingly low freight rates which can be justified from the railroads' standpoint by consideration of the selfish advantage to the railroads of agricultural productivity and rural thrift.
7. Close working accord between all groups, including producers, users, scientific research men, agricultural educators, etc.
8. The realization by the farmer of the price basis and conditions under which he can with profit and fairness to both himself and the producer make full use of this material.
9. The farmers' financial status or ability to buy freely.

Let us each get behind the other in mutual support. You quarry men have need of a prosperous agriculture. Farmers need your support, not only in the terms and conditions under which you sell them limestone, but also on general matters involving the economic status of agriculture and its restoration to a place of equality with other branches of industry and commerce.

Gypsum Lath in Bundles

Gypsum lath in bundles that are handled by the lather with at least the same ease that wood lath is handled, was announced at the Silver Anniversary Convention of the United States Gypsum Company under the trade-name of Bundled Rocklath. Each bundle contains lath for the covering of thirty-two square feet of wall and ceiling surface. The individual pieces of lath come in two sizes. One is 16 inches by 48 inches, and of these there are six in a bundle. The other is 16 inches by 32 inches, and of these there are nine in a bundle. Each bundle weighs 60 pounds.

It was announced that Bundled Rocklath was developed only after fourteen months of investigation among the lathers and plasterers of 165 cities. The investigators went on to the jobs with the workmen to learn precisely what was wanted in the way of a plaster base. The data thus gathered was tabulated and correlated, and the final product, according to the announcement, is simply an attempt to give the lathing and plastering trades a product identical with their requirements.

Each piece of Bundled Rocklath is three-eighths of an inch thick, has a three-ply nailing edge and can be plastered on either side. It also can be applied vertically in closets, corners and angles. The kraft paper covering is sufficiently porous to prevent slipping under the trowel while the plaster is being applied. Edges of the individual pieces are rounded to make for easy handling. The boards can be butted together, as tests recently conducted showed that the adhesion of gypsum plaster to plasterboard is greater than to any other type of lath. Consequently "keys" are not needed. If, however, it is a trade-custom to space the boards, this can be done, but the spacing should be a full three-eighths of an inch to give the joints a strength equal to the body of the wall.

According to announcement, Bundled Rocklath is virtually unbreakable in the bundle and is not subject to damage in the piece. It requires only half the number of nails required for wood lath over an equal area, and because of its pure gypsum core it can be scored as satisfactorily as it can be sawed. The bundles permit quick estimate by the contractor of the material on the job; easy transfer from room to room, and easy storage in the dealer's warehouse.

VIBRATION IN QUARRY OPERATIONS AS A PRACTICAL LEGAL PROBLEM

By Harold Williams, Jr.

Member of the Boston Bar*

THE EFFECT of vibration from quarry blasting on buildings in the vicinity of the quarry is a problem of growing importance in the practical side of modern quarry operation. The law books are full of cases of blasting damage done by blasting. Most of these cases refer to direct damage, damage caused by the direct impact of the blast, such as throwing stone and rock causing air concussions in the immediate vicinity and otherwise disturbing immediately adjacent property. The modern problem is entirely different from that and all the old laws and the old cases have got to be thrown aside in considering the problem that we have now. The introduction of well-drill shooting means that while the shots are much less frequent in number, they are more deeply laid in the earth and consequently their effect, their vibration effect, is more widespread. That is to say, instead of producing noise and air concussion, they are much more apt to produce vibrations of the earth.

Vibrations of the earth are indirect in their effect and this is a difference that you have always to bear in mind when you are considering this question of vibration. A vibration is not a blow to a structure. A vibration is a blow to the earth a long distance away and what comes to the structure is not the blow but the vibration resulting from the blow. It doesn't make any difference what causes the vibration. There are plenty of instances where heavy machinery may cause a vibration. There are cases where trucks or railroads or any other sources of local disturbance may produce vibration so that the producing cause is of no consequence. Therefore, these cases are not properly explosion cases at all and we who have to deal with them in the law courts always have to remember that very clearly and try to make everybody else understand it as clearly because when you are dealing with explosives, you are dealing with a dangerous substance and if it can be made to appear that what you are doing is exploding vast quantities of powder and thus causing damage, it puts you in a worse light and it puts you in a false light, because it doesn't make any difference how you cause your vibration.

These are not really explosion cases at all. Consequently the law governing the production of vibration and causing damage by them varies somewhat from the law affecting cases of direct impact and damage. It is generally held, although we can't yet say it is universal, that you are not liable for the effect of vibrations which you cause unless you have been negligent. The meaning of negligence in this regard is not as you would think it was, simply a technical question of firing your shot. Of course your shot must be properly loaded. It must be from holes properly spaced with regard to one another and with regard to the face of the cliff. It must be carefully set off and in all the details of conducting it it must be faultless, but that is not all the duty. That is not enough to rebut the idea of negligence. There may be some instances where it should be negligence to shoot at all where buildings are so very near that they would be almost certainly hurt. There may be instances where it would be negligent to shoot a shot so large that it would be likely to cause damage. Those are questions for the particular tribunal in the particular case and we can only lay down as a rule for our safe guidance the rather general proposition that next to that absence of negligence is the conduct that a reasonable man would have under the circumstances of the particular case.

There is another possible phase of liability. I think we need not, however, regard it very seriously. A man may be liable for the use of his land although he is not negligent. He may be liable for creating a nuisance. If a nuisance is an offensive condition of premises, it is a condition which makes the premises offensive to the neighborhood. It is not very likely and as far as I know there is no decision to that effect, that the opinion of a quarry with well-drill shooting could be so regarded as a nuisance. It lacks the feature of continuous offense, which the definition of a legal nuisance means. I mention this only because it is possible that that sort of claim may be made against a quarry operation at any time.

The only other strictly legal matter that I want to mention as a preliminary is the question of obtaining the proper licenses or permits which the local law or municipal authority may require. That is, of course, an important feature of your work. The absence of a license, when the license is required by law, may be and generally is held to be prima facie evidence of negligence. On the other hand, where a license is once granted it operates strongly as a protection and courts very frequently will hold that where the license is granted and the operation is conducted in observance of the terms of the license, then there can be no wrong-doing. So that we may say that if a quarry possesses all

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the necessary permits and licenses and is operated without negligence, defined as I have intended to define it to you, it is proceeding within the law.

Unfortunately, however, that doesn't free us from liability to attack and there are a number of ways in which the attack comes through the processes of the law against the quarry operations.

In the General Crushed Stone Quarry in Winchester, Mass., we have met, we think, all possible forms of attack, and in describing the nature of what we had to undergo and how we had to meet it, it will be put in a more personal and reminiscent way and perhaps a more picturesque way what I might put in more cut and dried fashion; so you will pardon me if I make this part of what I have to say reminiscent, perhaps with personal application to the actual suits that we have gone through.

This quarry in Winchester, Mass., had been operated for some years before the General Crushed Stone Company came there, and there had been a general feeling in the neighborhood that it was causing damage. There had been some adjustments made such as is very natural to make with persons who claimed that their houses had been injured, small things had been fixed up, plaster fixed up, windows, or things of that kind, and that had tended to promote the general feeling that the company realized that it was in the wrong. This feeling seemed to grow and complaints seemed to grow upon what fed them, and therefore this company determined to make a careful and scientific investigation of the whole problem, not in the first instance as a means of defense against any particular suit, but as a means of informing themselves as to what they were doing and what the effects of what they were doing were, so that they could from that time on conduct themselves according to the legal rights and with respect to legal rights of those about them. In other words they didn't want to get into any trouble. They wanted to know what they were doing.

The result of this investigation, which you will hear more about later, was surprising. We were amazed to find that the vibration caused by our blasting was so small, so infinitesimally small, that it was difficult to measure them, difficult to deal with the records of their measure. In other words a vibration is something that when you feel it yourself, you magnify very much its actual effective faults.

When our investigation was well under way and we had begun to reach these conclusions, we were confronted with our first law suit. A bill in equity was brought to enjoin a plant from doing business by an owner of a house about 1,800 feet away from the face of the quarry. As is customary in cases of that character, it was referred to a master before whom the hearing were held. These hearings proceeded for about seventy-five days and covered a period of several years with the intermissions between them. The first difficulty that we found in defending the case was this. The plaintiff, the owner of the house, comes into court and his family come into court and his friends and neighbors come into court and they tell the court what they have seen. They say, "We saw what happened as a result of the blast. We saw our walls crack. We saw pictures fall off the wall. We saw ornaments fall off the shelf. These are things which we ourselves saw."

It is pretty hard to combat that. We didn't have anybody in that particular place at that particular time. We couldn't say those things didn't happen. We couldn't back up that assertion by the evidence of anybody who was there and had personal knowledge as a result of his own observation. All we could say was, "Our investigation showed and we can prove to you that these things could not have happened." That is a difficult defense. Any of you who have ever had experience with court cases and even such of you who haven't, can remember, I imagine, the position that a person is in when he is accused of doing something by eye witnesses, alleged eye witnesses, and is unable to disprove it by witnesses of the same character. It is a real difficulty. A court or a jury is going to say, "You may bring in scientific evidence to show it couldn't happen, but it did happen because these people saw it."

That is the fundamental difficulty we are up against in the defense of all these cases and it is a very real one. Of course, you have to deal with that; it is really a lawyer's problem rather than a scientific problem, dealing with witnesses to determine whether they really did see and know, or how much is inference from something else that has happened. The human body is immensely susceptible to vibrations. It is one of the finest mediums of receiving vibrations, but of course it is not a measure of vibration at all. People who experience a vibration readily believe that it moves far more than it really does, and therefore people will come in, very often in good faith, and tell you of a personal disturbance of themselves which we know could not scientifically exist or happen. They may believe it. There isn't any way of measuring it on their part and it seems much greater than in fact we know it to be.

After you have boiled their story down to its smallest circle, there still remains a remnant of alleged personal testimony which has got to be met, and that was our ultimate problem. We met that by showing, in the first instance, the scientific impossibility that the damage which they claimed could have resulted from the blast they complained of. Here we had a certain advantage over the other side because we had studied with some care a problem almost entirely unknown to people in general, information (I think it may be said with approximate truth) that until we began to study out the quantitative value of these vibrations with reference to their effect and with comparison to their effects, had never been studied before. The vibrations had been observed, perhaps had been measured, but they never had been compared with the resistance strength of building materials, so that we knew somewhat more than our opponent, and that gave us a certain advantage of handling the case, and it was rather easy to get a lawyer tangled up in scientific things he didn't know about and make it quite clear to a court or jury that he didn't know what he was talking about, and that, as you know, always happens.

The first method of measuring vibration is, of course, by seismograph. A seismograph is in most of our mines the large, unwielding thing they have in observatories to follow and pick up the record of the large, slow, cumberous motions produced by an earthquake. These motions compared to earthquake motions are about the same as the wiggle of the minnow would be compared to the ponderous motions of a whale. These vibrations wouldn't be perceptible on any such instrument as that, but we found a portable instrument which could be taken about and set up in various localities which would give us the measure of the vibration. This instrument would give us, as it is called, the acceleration, which is the measure of the vibration, from which you are able to calculate mathematically its effective force. Given the effective force of the vibration, it becomes another mathematical calculation to reduce that to terms of static pressure, you are in a position to compare it with the known strength of building materials of various sorts, such as stone, plaster, concrete, wood, or whatever substance you have to deal with, and so you are able to show not as a matter of opinion but as a matter of mathematical demonstration in a given case that your vibration would have to be ten or twenty or perhaps 100 times as big as it is in order to approach the breaking strength of the various building materials. This isn't given as an opinion, it is given as a calculable fact, as much a fact as any fact that is testified to in the evidences of cases.

In this injunction suit we were fortunate in having the court order that the master witness judge such an experiment. We had the master come out and watch the holes loaded. We had him go to the plaintiff's house and see the seismograph installed. The signal was given and he witnessed the blast and the recording on the seismograph. He saw the whole thing and how it was done and in that way, from the calculations which we were able to take from that blast, we were able to demonstrate to him, as I have said, as a matter of mathematical certainty, the size of the blast and its absolute incapacity to do the damage blamed against it.

However, we are not always so fortunate. Sometimes a man may bring a suit against you and complain of something you did a year ago, and it is too late then to set up a seismograph in that house and show what that particular blast did. It is too late sometimes to have direct evidence in the particular case. Then you have to proceed by the analogy of blasts you have taken, records you have taken in other houses and of other blasts at other times, which, of course, have to be reasonably analogous in circumstance or you wouldn't have relevant evidence. We have developed a device which checks the seismograph and tells its story better than the seismograph can tell it, which is so simple that it is open to any man to develop and use as often and as frequently as he wants to.

It grew up in this way. On the occasion of one considerable blast at our quarry, Professor Rockwell of Rutgers University, happened to be at a certain house for purposes of observation there. They wouldn't let him in, but they couldn't or didn't stop him from balancing a pencil on a piazza rail. That pencil remained standing throughout the blast. It withstood the onslaught that afterwards was claimed to have tipped over a chair with an old woman in it, to have thrown bricks out of the chimney, to have cracked a stone foundation wall, to have thrown pictures and clocks off the walls and broken them, and to have done limitless damage of that kind. The pencil somehow or other was able to withstand that and stood erect throughout.

Professor Rockwell was able to calculate, knowing the dimensions of that pencil, just how much force was required to overturn it. In other words he knew how big that vibration was. He knew that it would have to have a certain amount of acceleration in order to turn the pencil over, and if it didn't turn it over, it wasn't as big as that.

Working from that, Otho M. Graves, evolved a set or series of steel pins which I have here and which a good many of you have seen. There is nothing magic or mystical about any of them. They range in height from fifteen inches to four inches. We stand them up. You can make as many sets as you want. We stand them up in something like an umbrella stand or a grand stand; it slopes down towards the front and has the effect of being framed. This keeps these pins from knocking each other over. We are able to set these pins up anywhere we want to, and if a vibration is sufficient to knock over a fifteen-inch pin but not sufficient to knock over a twelve-inch pin, then we have that force confined within two ranges. We know that it is as big as to overturn the longer pin, and we also know it isn't as big as would be necessary to overturn the shorter pin. The only trouble with it is that we can't get vibrations big enough to knock over any of the pins,, and in a number of experiments I think the only one we have ever knocked over was the fifteen-inch pin, which is quite an art to stand up anyway, and that was only knocked over when we were very near, two or three hundred feet from the quarry.

These pins have a scientific value in that they check the seismograph. They also have a value, to my mind, a very much more interesting and practical value, because they demonstrate to the layman, to the untrained mind, and in other words, to a judge or jury, in a graphic way which no record could, the facts to which they bear witness. Any man can understand a pin like that standing up and not being knocked over. It tells its own story and it refutes the stories of great damage which may be told as consequent upon the same blast. Therefore, its value to me in court is much more than merely scientific value.

This injunction case of ours gradually drew itself to an end. The enemy realized that he wasn't getting anywhere and that it was taking a great deal of his time and other things he valued, and finally he sold his building for just as much as he ever could, and after that, of course, he didn't need an injunction and his suit died a natural death.

Our next case came several years after that and it was in the nature of an attempt to revoke our license to store explosives. This was a hearing before the city council. That was political rather than legal in character. It wasn't confined within the ranges of the law of evidence. People could come in and make charges against us, accuse us of everything from murder down, and, of course, they didn't have to prove anything and couldn't answer anything, and so that hearing took a rather wide range. Perhaps it isn't very important to go into very much here. Our answer to it was, of course, that a demonstration of the results of our scientific work showed we couldn't do the damage they said we had, showing with pins, giving them data resulting from the use of the pins and, of course, pointing out to them the fundamental importance of this industry to any community which it serves, not only as an employer of labor and payer of taxes and a consumer of local products and hirer of local trucking, but as a real public service to the town, the county and the state and to the railroads, and we were able to get people to come in and back us in this respect, people whose tribute was a real compliment to any concern in whose behalf they would voluntarily appear to help. The result of this hearing, after a rather stormy session and a rather close vote, was that the license was not revoked, so we were still permitted to live.

The last attack made on us was really the most dangerous of all, although its immediate consequences were perhaps the slightest, and this was the trial of two cases which had been brought for damages and which were to be tried before a jury. It wasn't that the particular damage was so very great, the alleged damage, but there were hovering in the air a crowd of vultures ready to descend if there was a carcass to descend on, and it became very clear that it was an extremely important case for us to win, because if we didn't win it, we would be deluged with an avalanche of other suits.

The court room was filled with other people watching, awaiting their chance. In this case we depended on a manner I have described to you. We were fortunate in one circumstance. One of the houses involved in this case was the same house at which Professor Rockwell had originally balanced the pencil on the piazza rail and he had done it on the occasion of the very largest blast we had ever set off, and that pencil experiment, developed as it has been in pins, proved its practical value conclusively because in the face of the fact that the pin stood, it proved to be impossible for the plaintiff to satisfy the jury that all the things which he claimed had happened, and which I have described to you could not have happened, and it was manifest that the evidence was unreliable in the face of the silent evidence borne by the pin that remained standing throughout.

There is another feature of evidence which must never be neglected in any of these cases. Cracking in walls are very familiar incidents in the life of a contractor or builder or any construction engineer. They come from well known causes and the source of their origin can be pretty accurately arrived at. You should never neglect, in any case where you are threatened with a claim of this character, to have a careful examination of the building made by competent builders and engineers, and selected, of course, with reference to the particular task. This is always a strong method of answering the plaintiff's case. The plaintiff will say very rarely that he saw the crack yawn in the wall or ceiling as the vibration took place. Few men will have the effrontery to come into court and swear to anything like that, and when they do, you have to deal with them as every lawyer has to deal with a palpably mendacious witness. That isn't anything that interests you much. The average man in court testifying that the blasting has cracked his ceiling, his evidence boiled down amounts to nothing more than that he noticed the crack up there a day or two after the blasting and he had never seen it before. As the year went on and there was more blasting, the crack seemed to grow worse and therefore he inferred the blasting had caused the crack.

That kind of evidence you can answer very well by the expert examination of some trained man, some builder or contractor. He sees what did cause that crack. Every builder knows that foundation settlement will cause cracks in plaster and cracks that you can trace by their direction to the settlement from which they spring. Timber shrinking will pull down with it walls or partitions dependent on it and cause a rupture of the plaster, and when you see the timber and see the shrinking and see where it has shrunk from what it originally was, you can directly trace to it the cracks complained of.

The contraction and expansion due to changes in seasons, whether a building is heated or not, may often have its effect. These things are readily discernible and readily demonstrable, and the average contractor or builder makes a very good witness because he is apt to be one in close contact with the type of men from which our juries are generally drawn and speaks a language they understand. That kind of a witness is very helpful as a variation from the scientist who perhaps is someone they can't so readily understand. So that is a phase of the defense which we employed in all of these cases and which we found valuable. We found that particularly valuable in these jury cases. By the way, the result of the jury cases was two clean verdicts for the defendant, and we succeeded in satisfying that form of legal tribunal that we weren't and couldn't be doing any damage.

The immediate interest of this to you, if it has any interest, is what bearing it has on your prospective problems of the same kind; for you are all, almost all of you, going to meet in the course of the next few years with the increase of population around everywhere (they are growing nearer and nearer to you), with those problems.

In the first place you must, of course, be sure that you have all the proper licenses or permits that the state or the township or county or city may require. Without them, of course, you are in wrong to start with. With them you have the protection which they give.

In the second place you should keep a careful and probably a diagrammatic record of your shooting. You should know as to each blast and the date on which it occurred. You should know the amount of dynamite used, the number of holes, spacing with reference to the face of the cliff and with reference to each other, the details of the loading and the amount of the stone resulting. No doubt you keep these things, but that is something that must be done so that you will know how to answer the allegations, the charges made against you in behalf of any particular shot.

Then you must always remember that this is largely a psychological question. Many of the people who complain really believe what they say. They believe it for the reason I have touched on before, that a vibration experienced by a human body seems so much larger than what we know it really was. People will tell you that they seem to have been raised a quarter of an inch whereas we can show the same vibration which gave them that sensation as a matter of fact didn't divert them or change their position more than a fraction, one-hundredth of an inch; in other words, about the thickness of a sheet of paper, and yet to them it seemed and they may have meant it so, a considerable disturbance.

Of course, psychology has a very big part to play in this, and you have to bear that in mind. If your neighbors are friendly to you, they are much less likely to think that this amounts to anything or that you are doing them any harm. They are much more ready to believe you when you show and try to prove to them that you are not doing any harm. On the other hand, if hostility creeps in, it spreads and it becomes a source of menace to you. You have to bear that in mind. That is a case where the mental side, the imagination side of it plays a very large part.

We hope your neighborhood is friendly, but if there is anyone who is going to give you trouble, be prepared for him. Perhaps you can't set up a seismograph in his house. Perhaps he wouldn't let you. Perhaps it would be expensive or unnecessary anyway. Perhaps he wouldn't even let you watch a frame full of pins up in his house, but there is nothing to prevent your setting them somewhere near his house, somewhere on a line between the quarry face, the source of the disturbance, and his house; and in that way, if you will do that (it is something within the reach of anybody; anybody can make these pins), you will have a record. The simpler these pins are and the more free from artificiality and mechanism, the more effective they are as evidence as to what happened.

There is no reason why you shouldn't take that precaution where any threatened trouble is concerned, and in that way you will be ready for it when it comes. When you are satisfied that your operation is reasonable and legal and when you are satisfied that you are not doing any harm to your neighbors, don't weaken. Don't give way and make adjustments which seem to acknowledge that you are in wrong. Be firm about that, and if you are sure you are right, and that your operation is reasonable, the best thing for you to do is to go ahead and trust that the courts of your country will protect you and give you justice. That is all any man can do in a case like that.

Detonation of Explosives

The factors that affect the products of detonation of explosives, particularly the quantity of poisonous gases and combustible gases produced under mining conditions are being studied by the Bureau of Mines, Department of Commerce, in an apparatus giving products of combustion comparable to those obtained under actual mining conditions. During the past fiscal year a number of permissible explosives were studied with special reference to the effect of confinement on the poisonous and combustible gases and the effect of coal dust on the gases produced under coal mining conditions. During the present year it is planned to use different sized chambers on the apparatus, and to study effect of the combustible gases with the view of correlating results with gallery and flame tests.

MINERAL AGGREGATES FOR HIGHWAYS

A. S. Rea

Engineer of Tests, Ohio Department of Highways and Public Works*

CONTRASTED with the policy of a number of other states, Ohio has followed in our highway work more or less of a diversified program. Some of the states, as you perhaps know have limited their construction to one or two types. I think that perhaps in Ohio we have as many different types on our state highway system as any state in the Union. Then too, so far as material specifications are concerned, we have always had more or less open specifications and have not limited our materials to any one class for any type of construction. For instance in macadam—bituminous macadam—we use both tar and asphalt. For concrete we use sand and gravel and also crushed limestone and slag. While we have more miles of gravel concrete than concrete using any other coarse aggregate, we recognize that it is possible to obtain fairly satisfactory concrete with other aggregates.

When we speak of mineral aggregates in highway engineering our interpretation of the word "aggregate" is in the more general sense and includes gravel for gravel roads, stone and slag for macadam, etc., as well as these materials for concrete. For example: Our specifications state that the coarse aggregate for macadam base shall meet a certain specification and be of a certain size, all of the other State Highway Departments follow the same plan so far as I know. This interpretation does not agree with tentative definition of the term aggregate as proposed by a Committee of the American Society for Testing Materials, which is as follows: "Designated inert material which when bound together in an agglomerated mass by a matrix forms concrete, mortar, plaster, etc." It will be readily seen that this definition does not contemplate the use of the term aggregate for gravel or stone for such use as gravel or stone macadam. It should be remembered, however, that the definition referred to is only a tentative one, and since several revisions have already been made in the wording of the definition, it does not necessarily represent the last word. I think, without doubt, most highway engineers will continue to use the word in its more comprehensive interpretation.

In every type of highway construction, whether it be a hard surfaced pavement, so-called permanent pavements, or for traffic-bound gravel roads, so-called stage construction, as well as for all classes of highway structures, mineral aggregates of one type or another are used to some extent. I wonder if the producers of aggregates themselves realize the extent to which their product enters into the vast highway program. It is, I think, very conservatively estimated that of the total mass of materials incorporated in our highways that no less than 90 per cent of the total volume is composed of mineral aggregates. It is, of course, not a difficult thing to calculate this for any given type of construction. I have done this for a number of different types of pavement, and roughly estimated the per cent for the State Highway System of Ohio. This varies from approximately 57 per cent by volume of mineral aggregates in a 3½-inch brick pavement with a one-inch sand cushion on a 5½-inch concrete base to 100 per cent for a gravel road or a waterbound macadam road. The per cent by volume of mineral aggregate in a concrete pavement 1-2-3 mix, disregarding the water, would be 5/6 or 83.3 per cent. It can be readily seen, therefore, that the tonnage of aggregate incorporated in our highway system is enormous.

Referring now to the State Highways in Ohio, we have 88 counties in the State. The State is divided into eleven divisions, each division having the same number of counties—eight. Each division is in charge of a Division Engineer, who has his headquarters in his division, and is responsible for all construction and maintenance work within his division. At the present time the State Highway System having a total of approximately 11,000 miles has over 9,000 miles improved or under contract. Up to January 1, 1927, 8,800 miles had been actually completed, as follows:

Waterbound Macadam	1,267 miles
Bituminous Macadam	1,259 miles
Portland Cement Concrete	1,543 miles
Brick	1,339 miles
Bituminous Concrete	239 miles
Sheet Asphalt	33 miles
Rock Asphalt	143 miles
Traffic Bound	2,967 miles
Earth	40 miles
	8,830 miles

Roughly then the construction completed is composed of two-thirds pavement and one-third traffic bound, chiefly gravel. The pavement is divided approximately, one-fourth waterbound macadam, one-fourth bituminous macadam, one-fourth concrete, one-fourth brick. In general, the State of Ohio is well provided with highway materials, particularly with respect to mineral aggregates. It is much more fortunate in this regard than many other States. In the Western half of the State many outcrops of limestone and dolomite are found. The Eastern half of the State is underlaid with

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sandstone, shale, and coal. In some sections of the Eastern half limestone deposits are found to a limited extent. As a general rule, most of the limestone and dolomites are suitable for highway construction. The stone from some of the geological formations is too soft for use in wearing courses, but may be used for base courses. The sandstones found in the Eastern half are relatively soft, and are not used in highway construction, except in foundation courses. Some of the stone is even too soft for this purpose.

As previously stated, the Western half of the State is dominantly a limestone area, and the Eastern half is dominantly a sandstone and shale area. This is true provided the unconsolidated or mantel rock is lifted from the bed rock. North and West of a line passing through Lisbon, Canton, Millersburg, then south and southeast through Hanover, Sugar Grove, Chillicothe, Bainbridge and Ripley (which line in a general way parallels the Ohio River) this mantel rock consists of gravel, sand or clay or a mixture of all three, resting directly on the hard fresh bed rock. South and east of the line on the other hand, the mantel rock of sand, clay and the like, grades gradually into the bed rock beneath. The unconsolidated rock of the former area was brought in and deposited by the great ice sheets which covered much of northern North America. That of the latter area is the residue formed by the disintegration of the bed rock and the line between is the glacial boundary.

In many places within the glaciated area the waters formed by melting of the ice sheet assorted the glacial material and deposited it in beds of gravel, sand and clay. This was so commonly the case that most counties within this area have more or less widely distributed beds of gravel and sand which may be utilized when properly prepared for highway construction. In a general way the gravels found in the western half of the state are composed largely of limestone pebbles with certain of the glacial gravels containing a considerable per cent of igneous rock, such as granite, trap, and quartz. The gravels found in the eastern part of the state and also the Ohio River gravels contain more or less sandstone, some of which is very hard, together with quartz and granite.

With reference to the quality of the gravel and sand found in the state it may be said that as a rule it is very satisfactory for either concrete construction or for traffic-bound gravel construction. Enormous quantities of bank gravel and river gravel including the Ohio River gravel have been and are now being used for highway construction. Sand screened from such gravels as well as sand from Lake Erie on the north has been extensively used for concrete. The Lake sand is also widely used for sheet asphalt and bituminous concrete construction. As previously indicated, slag is included among the mineral aggregates used for highway construction. Slag which is used in highway work is obtained as a by-product of the blast furnace in the production of iron. In certain sections of the State where little or no gravel or stone is found locally, crushed slag has been used rather extensively in both macadam and concrete.

Just a word about the various grades and classes of mineral aggregates used in highway construction with some reference to the types of construction in which they are used. The Ohio specifications during the past season covered 23 grades or classes of mineral aggregates (9 classes of fine, 14 classes coarse). A number of these, however, are really, obsolete in that they are little if ever used, except possibly in a few special cases. For example, the specifications still carry the requirements for grout sand for brick pavement. This type of filler has practically been discontinued in favor of bituminous filler. A number of the classes of aggregates will be eliminated in the 1927 specifications.

In the nine classes of fine aggregate were included the requirement for two grades of concrete sand, designated as grade A and grade B, the former specified for concrete pavements, and the latter for concrete bases, also in addition to the sand for grout the specifications covered sand for cushion under brick, sand for filler to be used with tar or asphalt as a mastic, a very coarse sand for covering as a surface treatment in asphaltic concrete, screenings for macadam, and also an asphalt sand for sheet asphalt and bituminous concrete construction. It is, of course, understood that a difference of quality is not necessarily involved in specifying such a large number of grades or classes. The same producer can and does furnish without any difficulty a number of grades. It is simply a matter of properly screening in many cases as represented for instance in the production of a concrete sand and a mortar sand. Certain types of construction require particular qualifications as to grading. A first class concrete sand would be a very poor asphalt sand, and vice versa

As stated before the material specifications for coarse aggregate covers 14 different classifications, including 4 grades of limestone, 3 grades of blast furnace slag, and 4 classes of gravel. You will note that a distinction has been made between "Grades" and "Classes." In regard to both limestone and slag the classifications are based upon quality of the aggregate. For instance a higher resistance to wear, higher hardness and toughness are specified for grade A limestone than any of the other grades. In the same manner grade A slag must be of a better quality than grade B or C. In the case of gravel, on the other hand, while there are four different classifications there are but two grades so far as quality alone is concerned. Grade A gravel with a per cent of wear of 12 specified in the modified Deval test is specified for concrete pavements. Grade B gravel with a loss of 25 per cent is permitted for concrete foundations not subjected to wear. The other two classes of gravel: Namely, Gravel "C" and Gravel "D" are for Gravel Base Course and gravel for traffic bound construction respectively. I might say in this connection that the traffic bound gravel roads have proven so popular and successful in this State that at a recent meeting of the engineers it was voted to discontinue the old type of waterbound gravel, hence Gravel "C" will be eliminated from the revised specifications.

In conclusion, I wish to say a word about the work which has been done in this State in the last two or three years in the construction of gravel roads. Up to January 1, 1925, we had but 600 miles of gravel road under state maintenance. Up to January 1, 1926, there had been completed 1,608 miles of traffic bound construction. During the past year 1,359 additional miles were completed. It is expected that between 1,600 and 1,700 miles will be added during the year 1927. To some of those from other states it might be of interest to know something of the specifications for the class of gravel used for this purpose.

The specifications for Gravel "D" state that the gravel shall be composed of hard, durable particles of stone thoroughly clean (before crushing). The gravel shall be crushed so that the portion retained on the ¼-inch screen shall contain not less than 40 per cent of angular pieces. The per cent of wear shall be not over 12 per cent. In grading it is required that not less than 95 per cent shall pass a ¾-inch ring, 25 to 75 per cent pass a ½ inch, 15 to 35 per cent pass a ¼ inch, and not over 15 per cent pass a No. 10 sieve.

The type of construction as many of you know has proven extremely popular in certain sections of the State. It is granted that it will be many years before all the roads on the state system can be hard surfaced. In many localities of the state the construction of high-priced pavements is economically unjustified. The construction of the gravel roads has enabled some of the poorer counties of the states, as Governor Donahey has expressed it, "to break the mud quarantine" and has given them splendid all-year serviceable roads in these communities, at a cost of approximately $3,000 per mile (including the grading).

The earmarks of business depression in the building industry are absent. Costs of building materials are stable, labor is highly efficient and wages generally stabilized. As the money market is a most dependable barometer of business, it can be seen that there are ample funds with which to carry forward essential and necessary building improvements.

Moderate Decline In Construction

Total construction contracts awarded during January in the 37 states east of the Rocky Mountains amounted to $384,455,400, according to F. W. Dodge Corporation. These states include about 91 per cent of the total construction volume of the country. This was the second largest January total on record, although 16 per cent under the maximum January, which was last year. The entire decrease of last month is accounted for in a drop in New York City's contract volume, and two-thirds of the decrease is accounted for in the fact that January 1926 had a single fifty-million dollar power-plant job for New York City, which was not duplicated in last month's record. Comparing last month's total with that of December, 1926, shows a decrease of 28 per cent. It should be noted that this is again a comparison with an abnormally high month, the December total having been swelled by large subway and other public works projects.

The more important items in last month's building and engineering record were: $167,866,300, or 44 per cent of all construction, for residential buildings; $80,115,700, or 21 per cent, for commercial buildings; $58,954,700, or 15 per cent, for public works and utilities; $27,875,300, or 7 per cent, for industrial buildings; $17,012,500, or 4 per cent, for educational buildings; $10,417,200, or 3 per cent, for social and recreational projects; and $9,157,900, or 2 per cent, for religious and memorial buildings. Contemplated construction projects were reported for these 37 states to the amount of $755,762,600 during January. This was a 17 per cent decline from the amount reported in December and an 11 per cent decrease from the amount reported in January of last year.

Ten Million Combination Forming

According to information received a $10,000,000 cement and slag company merger is under way. President Beeghly of the Standard Slag Company of Youngstown, Ohio, and associates have purchased the Bessemer Limestone and Cement Company at a cost of over $5,000,000, advices say. It is proposed to include in the new company, in addition to the Bessemer Company, Standard Slag Company, Buffalo Slag Company and Federal Cement Company, the last two of Buffalo. Standard Slag Company has twenty-two plants, all in the Youngstown and Ohio river steel districts. A portland cement plant is contemplated for construction at Sparrows Point, Maryland.

Consistence of Cement Pastes and Concrete

The "flow table" test is satisfactory for determining the consistence of neat cement pastes and mortars.

IMPORTANCE OF RESEARCH ON INDUSTRY

By D. A. Abrams

Director, Research Laboratory, Portland Cement Association*

THERE is probably no one period in the history of the world that has seen such a rapid development along scientific and industrial lines as has the last quarter of a century. Those who can remember back 35 years, recall a great many things that we are doing today that would have been absolutely impossible and would have been considered the utmost foolishness if they had been mentioned as possible in those days. Practically all this has come about as a result of research and has been reflected in the industry development of our entire country. Possibly I should define what I mean by research. By research I mean the intelligent and continuous searching for knowledge as based on nature's truths and nature's laws. Now diligent investigation is not enough. It must be intelligent. So the intelligent feature is a very important element in the research problem.

Researches in industry are based on the application of nature's laws as we find by sciences, by physics, chemistry, mathematics, biology, etc. In the remarks I shall have to make, I shall say little or nothing of the wonderful contributions research has made to medical science and sciences of that sort, but rather direct my remarks to the more outstanding industrial developments. Research need not necessarily be a matter-of-fact procedure.

I am going to speak of some of the fashions of research in industry. These illustrations are so numerous we see them everywhere. It will be impossible to mention any except a few of the more important ones. Let's take the aluminum industry, for example. Twenty-five years ago aluminum was a rare metal. It took a nice polish, did not tarnish and had a great many elements of important industry material, but it was so expensive at that time that it was little more than a curiosity to be found in a museum. But what do we find twenty-five years later? Aluminum is one of the important metals of the world. The aluminum industry is one of the important industries of the United States. It is a direct outgrowth of the understanding of the methods of producing aluminum and the electric power necessary for that purpose. The aluminum industry is based solely on the results of industrial research.

Let's consider the electrical industries. A great many of these probably if they were all thrown together would doubtless so far as the final output is concerned be much greater than any one industry in the country. We have electrical tracks, electrical power, high tension and long distance transmission. All these are direct results of research. Telepgraph and telephones are historical examples that will occur to all of you. We are seeing new examples every day. We were only in the last week or two told of the new service of telephone communication between New York City and London. So these things are growing almost over night.

The automatic telephone is coming very largely into use as the result of continuous research along this line. The radio, an industry grown up within the last four or five years, is one of the large industries of the country now and is a direct result of research on the part of these organizations.

The General Electric Company, the Western Electric and the Westinghouse (I mention these—the largest corporations in the electrical field) employ literally thousands of men in the development of research work. One of the largest buildings in the plant of the General Electric Company is their research laboratory. They not only follow up the problems of immediate importance in their own industry, but scientists there have contributed probably as much as any other one to a better understanding of many phases of natural phenomena that were not understood before. In many cases there is no direct application of these laws in sight, but they developed the idea for when they will be useful.

Let's consider an artificial silk as an indication of industrial research. There is an old adage that you can't make a silk purse out of a sow's ear. One of our friends actually did that not long ago, just for a stunt. Silk can be made from animal and vegetable fiber and is being made in a large quantity. The artificial silk industry is seriously threatening the old natural silk industry and is making very serious inroads into the cotton and wool industry. The surplus cotton today is no doubt a direct result of the lack of foresight in developing the market. Markets may be established in one of two ways, either by curtailing production or by extending the demands. Unfortunately the cotton producers have overstepped themselves in production and have done little or nothing in expanding the demand for material. It is really a sad commentary on our industrial organization when an abundant crop of important material like cotton is looked forward to with dismay and regret by a large portion of our population. There is the place where the people interested in cotton textiles have allowed our artificial silk friends to put one over on us. These industries cannot always combat the developments of the competitors, but they can do a great deal in preserving themselves in many cases.

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The automobile industry is a direct bulletin of research. There you have a combination of a number of features such as the internal combustion engine, the vulcanization of rubber, the frictional spark, and the modern methods of finishing the automobile. I think one of the most dramatic stories I know in this connection has to do with the development of Duco finish for automobiles, which is applied largely to furniture and other items. As you know, in the old days, automobile manufacturers were hard-pressed to find room enough about their plants to store all the machines in process of finishing, especially bodies. From 28 to 30 days were required to apply these innumerable coatings of paint and varnish and enamel, and the whole plant was cluttered up with production if they did follow the most modern developments in finish. They readily came to see, if their market was to expand they must find some better and quicker way.

They went to the paint manufacturers with their problem and the paint manufacturers, after considering very seriously for some time, told them they had worked it out whereby they could finish these machines in 21 days instead of 28. That did not interest them in the least, because they wanted to be able to finish the machine in 24 hours, not 21 days. It then developed there was a new compound coming into the market in a small way for toilet articles and one thing and another. These people were approached with the problem of finishing the automobiles. They said, "Our material hardens in a very few seconds." So there you had the extremes at either hand—too long and too short.

But the problem was put up to these people, and they decided to try to work it out and did work it out so that automobile finishing today is a simple process as far as time is concerned—you not only get a cheaper machine in the end, but you get a better finished machine. That is the process now known as the Duco finish, developed by the Du Pont Company of Wilmington.

The story is told of these men holding this conference. The automobile manufacturer, after having developed this finishing method, invited his paint friend over to luncheon one day. The paint manufacturer parked his car out in front and the automobile manufacturer showed him some samples of finishes and asked him which one he would like to have on his car. His friend picked out one and when they came back from lunch the car was parked out in front with the new finish. So that shows what can be done in the development of this feature.

I shall not burden you with detailed mentioning of other of these important developments. You know them as well as I do—the aircraft field, explosives, packing and canning industry. All of these are developing wonderfully as a result of research. Even the undertakers are doing some research work to endeavor to find more lasting material for their caskets. I should not fail to mention the new developments in sausage casing. The packers have developed synthetic sausage casings, which are better than the old and the market will not be restricted.

As many of you know, I have been engaged for a good many years in studies of concrete and concrete materials, and I am going to take a few minutes to say something of the work we have done along that line, because I believe it will be of interest to you and I believe the methods and underlying ideas which encouraged us to undertake this work will also be adaptable to your own industry. This research work of the Portland Cement Association in which I have been engaged for a dozen years was not undertaken as a philanthropic proposition. The reason it was undertaken was because it was apparent there were a great many things in the way of the use of cement that were not understood. The cement manufacturers took the attitude that it was not sufficient for them to deliver to their customers a first class cement, but they must also assist these customers in seeing that cement is used properly, the proper use of material being just as important as the satisfaction and quality of the material itself. We had unfortunately seen a great many instances in which cement was not properly used. You no doubt know a great many yourself. So the organization of research in the Portland Cement Association was simply a reflection of the new business ethics, which implies that the rendering of service is just as important as the delivery of goods or equipment.

These researches, as I have said, have been under way a dozen years. We are now spending $150,000 a year in maintaining this work. The work was originally carried on with the Lewis Institute of Chicago, but we have now divorced ourselves entirely from the Lewis Institute. We have about 40 people engaged continuously in this work and we expect to have (we do not now claim to have) the best laboratory in the United States in which work of this kind can be done.

You may ask why it is we have to study concrete and why it takes so long to learn what we want to know about it. Concrete is a very complex material, made up as it is of many different combinations of material, many different types. The qualities of the material are almost infinite in their variety. There is almost no end of proportions in which these materials may be mixed. There is almost no end of usages to which it may be put, exposures to which it may be placed. So the problem does become one of very great complexity to find out all the facts we should know in order to design a concrete structure properly so it will give satisfactory service.

I think probably the most important thing we have learned about concrete in our investigations of a dozen years has been the importance of quantity of water in the vat. I think before these investigations were begun we might safely say we did not understand the fundamental principles of concrete at all. Concrete has been made it is true for a great many years, a great many decades, but we simply put materials together without any understanding of the real underlying principle of such a combination. We used to place all emphasis on the cement, the quality of the cement and the quantity of the cement, and now we find, much to our surprise, that the mixing of water is even more important than the quantity of the cement. You can get the kind of concrete that you make. You also get the kind of cement that you make. You talk about concrete failures, but they are not really concrete failures at all. We do know of course that it is entirely feasible to make perfectly rotten concrete out of perfectly good material. On the other hand, it is also feasible to make an excellent concrete out of indifferent, inferior materials, if they are properly used. So that is the problem we had set ourselves to solve, the method of making this concrete for the least money—concrete that will be durable and give a prompt action. I mention water ratio relation as one of the important things we have discovered. There are many other things, such as the time of mixing, the effect of curing, the effect of various mixtures, the condition of concrete in various agencies, expansion of concrete due to weathering, drying out, and many other factors of that kind.

We have endeavored to develop a new form of specification for concrete. The specification that has been developed (I am not sure that is the final form at all) puts a great deal of emphasis on the quantity of mixing water and a great deal less emphasis on the quantity of cement. I speak of concrete at length, because I know most of you, if not all of you, are quite closely in touch with the concrete field.

We have heard a great many things recently about developing concrete of high early tension. In building concrete roads and many other structures it is quite important to work them into open service at as early a date as possible. If it were feasible to open a road in three days instead of three weeks, that would be the thing to do. We have been able to show ordinary Portland Cement can develop the strength of the concrete in three or four days and open the road for service and avoid the delays that too frequently occur under the old arrangement.

This research work of the Portland Cement Association I believe is a very excellent example of what we may refer to as a group research. No one would feel it feasible to go into the research work that the Portland Cement Company has done, although some of them have organized research laboratories of their own and are spending as much money as the Association. But the organization of group research is a very striking development of the past few years in a great many industries.

Now, what about organization for industrial research? We must not forget we are searching for facts. When we find them we have got to face them. We can't dodge them. They are very disturbing things. The man who failed to change his mind may be very much the same class as the man who doesn't change his collar. He won't be popular with his friends. In order to conduct research it must be in the hands of an organization or a director who has had proper experience and must have proper equipment to work with. Your own organization has made an excellent beginning in this direction by the establishment of a research bureau.

Now, it might be properly asked what research can do for the sand and gravel industry. I am going to speak first of some of the problems which seem to me of outstanding importance so far as their application to concrete is concerned. The problem of the effect of size and shape of particle to concrete strength has not been fully worked out. We have done a great deal of work in our laboratory, but the problem is so complex that we do not know much about that line yet.

The problem of workability of concrete is ever before us. Anything that can be done to improve the workability of concrete is a step in the direction of better concrete, or on the other hand successful concrete at a lower price, and should certainly be encouraged. So the workability as far as your material is concerned is a very important factor. How is the yield of concrete made from gravel compared to the yield from other materials? The nature of the surface of the particles is an important factor and one which should be studied, and will be of great interest to your members.

The more satisfactory definition of certain factors in the specification of sand and gravel would undoubtedly be helpful to your industry as well as to the users of your material. The mixing of concrete —Do you know that gravel does or does not mix easier than other aggregates? It would be a very important question for you people to answer. So far as concrete, macadam, ballast, and other uses of your material are concerned, of course, we have always with us the factors of hardness, durability, etc., which have not been properly defined or specified. In plant operation, plant design and construction, no doubt a great many problems could be worked out in the community fashion which would be of great interest to all of you, screening, washing, crushing, etc.

In closing, I want to emphasize the possibilities of this group research idea. It is drawing a great many associations and a great many organizations.

TRANSPORTATION PREPAREDNESS

By W. J. McGarry

Manager, Car Service Division, American Railway, Association*

MOST of you are no doubt familiar in a general way with the organization and work of the American Railway Association and of our own branch, the Car Service Division, representing practically all of the railroads of the United States and Canada. You know that we are the joint representative of the railroads in the handling of matters of car distribution and supply; you know that we have harped for a number of years upon the question of heavier loading and prompt unloading of equipment. To bring about the desired results along these lines we have always endeavored to reach the men actually capable of giving such results, that is, the shipper and the receiver. The interest of the shipper and receiver and of the public generally in the successful working out of car distribution and supply problems is just as great as that of the railroads. On the face of it, it might seem that a wholly satisfactory solution would be the building of more and more cars until there were enough owned by the railroads to handle every possible demand for loading, regardless of how light the load per car might be or how much delay occurred in returning the car to the loading point for a fresh load. No one is in a better position to realize the fallacy of such reasoning than the men in your industry using, as you do, costly machinery which must be kept constantly productive in order to show a profit. The railroads are in exactly the same position. The purchase of large numbers of freight cars at an enormous cost to lie idle during periods of low demand would represent an enormous capital expenditure upon which interest must be paid, and such payment must eventually come from the users of railway transportation. The proper and efficient method, of course, is to so speed up not only the movement of cars by the railways but their handling by shippers and receivers and to bring about such capacity loading as will enable the railroads to move the maximum tonnage with the minimum number of cars.

Our efforts to reach the shippers and receivers on problems of this nature met with some success prior to the war. During the war, of course, everyone was willing to do his or her part and the only difficulty toward securing the desired results was a lack of adequate organized contact with the various units of industry, through which the necessities of the situation could be brought home to them. Following the war the railroads began casting around for a means through which such service problems could be brought home to shippers and receivers and through which the transportation problems of industry could be discussed, understood and settled, without the necessity of burdensome and often long drawn-out procedure before regulatory bodies. We feel that in the Regional Shippers Advisory Boards—with which most of you are no doubt familiar—this necessity has been largely met. I would like to speak to you for a moment upon the Boards and their accomplishments.

There are now fourteen of these organizations, covering the entire United States. The movement had its start in the Northwest in 1923. The railroads in that section, following their return to private control after the trying experiences of the war years, were in bad repute, as was generally the case with the railroads through the country. Car shortages came regularly with the periods of peak production and there was little in the way of active cooperation from the shipping public to assist the railroads in working out their troubles. In such a setting the Northwest Regional Advisory Board was born. We had a joint conference of all Boards in Chicago January last and I want to quote to you briefly from the report of the Chairman of the Northwest Board as to the troubles surrounding the organization of that Board and the manner in which these troubles were worked out:

"If necessity is the mother of invention the necessity in this case was great enough for a mother and father both. With farmers and shippers most thoroughly embittered; with railroads and transportation officers deadened by abuse and vituperation, it is small wonder that the early efforts, begun in December, 1922, to get these interests together did not prove enthusiastically successful. The first effort to get together met small response. A tenseness and reserve characterized the actions of the individuals making up the groups representing the shippers and the carriers. At any minute, nearly every member, composing either group, was primed and ready to inform the other group, individually or collectively, in language unrestrained, in just what esteem he and his group were held and where they could go. Little or no progress was made.

"Another meeting was called to meet in Minneapolis, January 16, 1923. Those who attended the first meeting had some time for reflection. The more they thought the better they felt toward the idea of a possible getting together. They told their associates and when they came together the second time the ice was broken. A fairly representative gathering of shippers and representatives of the

*Presented before the Tenth Annual Convention of the National Crushed Stone Association, January 20, 1927.

carriers were present. Mr. Donald D. Conn, Manager of Public Relations of the American Railway Association, gave fatherly advice; poured oil on the troubled waters.

"A permanent organization was formed and thus began the first of the so-called Regional Advisory Boards. This was purely an experiment. While apparently the lamb and the lion had lain down together, this was at that time more apparent than real. Mutterings were still heard. Many very pertinent questions were asked. Because I—a farmer—had been chosen chairman, some farmers began asking what was going to be done. My answer was a strong invitation to attend our meetings and sit in on the plan. Nothing would be concealed. Every card would be on the table face up. Every interest was guaranteed perfect fairness and equality. The slate was clean. All records would start from there. Any man or group, whether of shippers or different interests of shippers, representatives of the carriers or divisions of these representatives, would all be accorded the same consideration and full and complete equality. Any one, group or division, seeking unfair advantage would meet with short attention. Cooperation is what we sought. Every interest affected was approached and our plans explained with a very hearty and cordial invitation to sit in and help.

"Thus began an experiment in cooperative effort between groups heretofore with apparently so divergent views that it was regarded as an impossible undertaking and one destined to failure.

"Three years of operation has shown its worth, shown its effectiveness, shown its ability to help correct some of the most glaring defects in the service of transportation,—and most of these defects in shipping cured by the shipper himself,—until today, from this experiment and its success, similar Boards cover the country, all stressing cooperation and service and all working to a common end to attain this badly needed and much sought after desire.

"What about the carriers and their representatives?

"They have not only met every demand of our Board but have gone far beyond its demand in providing service. When the roads' own equipment was thought to lack ability to carry the load new equipment and power was provided without stint. 'Service' became the slogan of the carriers and today in the Northwest the most outstanding accomplishment of all industries is the manner and character of service now being rendered by the railroads. This service so greatly outstrips any ever heretofore given in this area that it forbids comparison."

As I said before, we now have, counting the Florida Unit of the Southeast Board, fourteen Boards, covering the entire country. It has been possible through these organizations to settle amicably numerous problems which, under old methods, would no doubt finally have been the subject of expensive and embittering litigation before the courts or regulatory bodies. It is impossible to estimate the actual savings to users of transportation which has accrued through this informal settlement of their shipping problems. We do know that the Boards and their works have been responsible in no slight measure for the very satisfactory transportation situation which has existed during the past several years. We do know that this satisfactory and efficient transportation has enabled a very material reduction in stocks and inventories in practically all lines of business, with a consequent enormous saving in interest charges and an evening out of the peaks and valleys of production. We do know that the Boards have enabled the railroads to interest the shippers and receivers in their problems, particularly the proper utilization of equipment under the Car Service Rules, and the heavier loading and prompt release of equipment. In the case of threatened car shortages we have been able to reach the interested shippers and receivers promptly through the Board organization with information as to what should be done in the handling of cars to avoid disastrous shortages.

Whether or not the railroads would have been able to handle the enormous tonnage of late years without the old time car shortages had it not been for the work of the Boards and the cooperation received through them, no man can definitely say. We can simply point to the record breaking tonnages handled by the railroads during these late periods, on the one hand, and to the understanding and sympathetic cooperation afforded by shippers and receivers through the Boards on the other hand, and say that this cooperation and assistance has been a very worth-while factor in the transportation accomplishment.

It is difficult, of course, to imagine the necessity for a large standing army in piping times of peace. We can all hark back to the days before our entry into the Great War and remember the arguments of those who felt that preparedness was an unnecessary expense. We can recall their resounding phrases to the effect that should our country be actually in danger a million men would spring to arms over night. We can also remember the speciousness of this argument as exemplified in our efforts to build up an adequate military organization after we did finally embark in the world struggle. We know now that it takes time, careful preparation and some building from the ground up to perfect a nation-wide machine of men, money and materials. This lesson is sound when applied to our Regional Board organization. Any argument to the effect that everything is running along smoothly in the transportation machine and that the few days in the year necessary to attend Regional Board meetings and carry on the Board business are not productive of good is specious and should be rejected. No man can say when emergency conditions will arise in our transportation machinery. Strikes, wars, disturbances in production and distribution, sudden expansion, such as in the State of Florida, and other numerous possible causes may easily overthrow the sensitive balance between car supply and car demand, and it is in the foreseeing and preventing of such unbalanced conditions that the Boards can find their greatest field for service.

I would urge all of you who have not done so to become personally acquainted with the Board movement in your own territory, to interest yourselves in the workings of your Board and to attend meetings and contribute your share toward the success of the Board organization. This done, I feel no hesitancy in assuring you that the satisfactory railroad service furnished during recent years will be continued and in all probability further improvement will be noted.

Sales of Lime in 1926

The lime sold by producers in the United States in 1926 amounted to 4,580,000 short tons, valued at $40,800,000, according to estimates furnished by lime manufacturers to the Bureau of Mines, Department of Commerce. This is approximately the same quantity, but a decrease of 4 per cent in value as compared with sales in 1924. The sales of hydrated lime, which are included in these figures, amounted to 1,570,000 tons, valued at $14,576,000, a small increase in quantity and a decrease of 5 per cent in value. The average unit value of all lime showed a decrease from $9.30 a ton in 1925 to $8.91 in 1926, and that of hydrated lime a decrease from $9.79 a ton in 1925 to $9.28 in 1926.

Ohio, the leading State, showed a decrease of 2 per cent in total sales and 5 per cent in sales of hydrated lime. Pennsylvania, which ranked second, showed an increase of 4 per cent in total sales. Of the 22 States in which more than 25,000 tons were sold, 12 showed increased sales, but in no State was the increase or decrease large.

Sales of lime for construction, and for chemical uses in 1926 were both about the same or possibly slightly less than in 1925 and are estimated at 2,372,000 tons for building lime and 1,893,000 tons for chemical lime. The demand for lime for use in agriculture appeared somewhat better in 1926 than in 1925, despite weather conditions—especially in the Central States which are reported to have restricted sales. The estimated sales for this use are 315,000 tons, an increase of 5 per cent.

Safety in Tamping

Loose fragments of rock falling in a bore hole while explosive charges are being loaded are a source of danger, warns the Bureau of Mines, Department of Commerce. Besides the danger due to the impact of the falling rock on the charge, there is the possibility that in tamping the charges the rubbing or broken cartridges or small particles of explosive between two pieces of loose rock, or between a loose fragment and the side of the bore hole, may cause a premature explosion. In addition, the frictional impact of the tamping bar against a thin layer of explosive adhering to the side of the bore hole might also cause premature explosion.

LIME SOLD BY THE PRODUCERS IN THE UNITED STATES IN 1925 AND 1926

State	1925 Hydrated Lime (Short Tons)	1925 Total Lime (Short Tons)	1925 (Value)	1926 Hydrated Lime (Short Tons)	1926 Total Lime (Short Tons)	1926 (Value)
Ohio	779,286	1,089,385	$10,970,605	743,000	1,069,000	$10,455,000
Penna.	219,737	794,951	6,425,675	225,000	828,000	6,615,000
West Va.	51,608	270,895	1,879,223	42,000	268,000	1,622,000
Missouri	71,290	273,348	2,610,954	82,000	253,000	2,188,000
Wisconsin	18,650	244,903	2,204,504	17,000	215,000	1,886,000
Alabama	25,989	207,699	1,679,155	30,000	202,000	1,613,000
Mass.	(a)	197,732	2,610,279	(a)	187,000	2,263,000
Virginia	52,374	192,429	1,491,568	56,000	187,000	1,381,000
Tennessee	48,364	175,685	1,344,508	52,000	183,000	1,352,000
Maine	(a)	115,571	1,291,812	(a)	134,000	1,452,000
Indiana	43,815	127,878	1,067,040	47,000	121,000	922,000
Michigan	(a)	95,036	909,952	(a)	111,000	1,053,000
New York	32,129	104,829	1,030,960	37,000	108,000	1,032,000
Illinois	(a)	96,066	928,632	(a)	101,000	999,000
Texas	29,529	74,638	698,138	34,000	81,000	726,000
California	8,715	70,805	745,132	7,000	76,000	811,000
Maryland	33,768	64,518	524,100	33,000	65,000	497,000
Conn.	(a)	58,449	672,821	(a)	56,000	540,000
Vermont	(a)	66,245	788,936	(a)	55,000	590,000
Arizona	(a)	39,045	394,023	(a)	53,000	518,000
Arkansas	(a)	24,791	223,965	(a)	32,000	276,000
Minnesota	(a)	(a)	(a)	(a)	(a)	(a)
Nevada	(a)	(a)	(a)	(a)	(a)	(a)
Washington	(a)	29,636	357,297	(a)	25,000	328,000
Undistributed	145,594	166,289	1,759,862	1,570,000	4,580,000	$40,800,000
	1,560,848	4,580,823	$42,609,141	1,570,000	4,580,000	40,800,000

1926 (Estimated)

a. Included under "Undistributed."

RELATION OF FINENESS OF AGSTONE TO ITS RATE OF SOLUBILITY

By H. F. Kriege

Formerly in Charge of Research Work, National Agstone Association*

WITHIN the past few years the application of limestone to farm land has changed from a poorly followed fad to a quite general practice. The removal of limestone from the soil through natural agencies, particularly leaching, is so continuous and so heavy a drain upon the soil's inherent supply that the present practice must soon be considered in terms of a necessity. This loss of calcium carbonate per acre of average tilled soil amounts to from 200 to 500 pounds annually. Thus an application of approximately a ton of limestone per acre every four or five years is needed to merely maintain the supply of calcium and magnesium in the cultivated land of today.

To be prepared to answer the questions arising from the more general use of limestone for agricultural purposes, the National Agstone Association has undertaken a study of the factors affecting the rate at which limestone becomes available in the soil. Such information as has been obtained works beneficially for the consumer as well as the producer of agricultural limestone. While certain differences in behavior will be brought out, it must be remembered that limestone, regardless of its characteristics, must be used in agriculture just as water must continue to be the chief agency to fight fire, regardless of the kind of water used. In cooperation with the soils department of the Ohio State University, the National Agstone Association established in 1923 a research fellowship to study the rate of solution of limestone. Under the direction of Dr. F. E. Bear, the problem was divided into three phases, field work, small plot studies and laboratory investigations.

For the field work, areas of from six to eleven acres were selected on eight farms in as many counties, well scattered throughout Ohio. These fields were divided into several plots which received limestone applications of different degrees of fineness, one plot being left untreated to serve as a check. The rotation of wheat, clover, corn, wheat, clover is being followed on these fields. The effects of the different grades of limestone are observed upon the soil and crops under normal field conditions.

A series of forty-eight small plots of 1/10,000 acre area each was made up, using the same soil (Mahoning silty clay loam) with applications of limestone differing in degree of fineness as well as in chemical composition. The purpose of these plots is to follow the several sizes of the limestone particles in their rates of correction of soil acidity under conditions somewhat similar to those in the field, yet being capable of closer control. Barley and clover are being grown on these plots so that the effect of the several separates may be observed not only on the soil, but also on the plants growing thereon. In both the field and small plot experiments, the applications of limestone were made upon the basis of correcting one-half the original limestone requirement, as determined by the Jones method, during the first year after application. The data from these small plots will be discussed shortly.

The third phase of the problem is the laboratory investigation. Studies have been conducted to determine the factors affecting the rates of solution of the various sizes of limestone particles under carefully controlled conditions such as temperature, hydrogen-ion concentration, etc.

In making the screen analyses of the limestones used in this problem, the Tyler standard screen scale was used. The advantage of this system lies in the fact that the diameter of a particle passing one screen is 1.414 (square root of 2) times the diameter of the particle passing the next smaller screen. Since the area of a given weight of regular shaped particles varies inversely as the diameter or any linear dimension, the surfaces of the combined particles caught on any screen must be multiplied by this same factor, 1.414, to equal the surface of an equal weight of the same material caught on the next smaller screen. If the material under consideration is homogeneous, its cleavage and fracture habits may be considered to be constant as the particles are reduced in size. If such is the case, it is possible to get an idea of the relative surfaces exposed by the several separates even though their surfaces are anything but regular. A method of determining the actual surfaces was devised and the above assumptions made in this rate of solubility study were substantiated.

As it was desirable to know what relation actually existed between the relative surfaces of equal amounts of the same material caught on different sized screens, this method was used with satisfactory results. A fairly large piece of the stone to be studied was worked down on the lap and oilstone to a regularly shaped body, one whose surfaces could be accurately measured with a micrometer. This piece was weighed and then shaken with a definite quantity (large excess) of the acid solution used in the previous solution study (.150 N.

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HCL). At the end of five minutes the shaker was stopped, the solution quickly removed from the sample which was then washed, dried and reweighed. This loss in weight then had taken place from a known weight and known surface of the limestone. Since solution can take place only at the surface of a particle, imposing similar conditions of solution to other sizes of the same material will give the surface of these separates directly when equal weights are taken. This method indicates that a close relation exists through the various screened sizes between the diameters or linear dimensions and the surfaces, even of very irregular bodies. For that reason, the assumption made early in this work that a knowledge of the screen analysis of a composite of limestone will give an idea to its relative solubility in field and laboratory, is given support. Recently a method quite similar to this appeared in a report from the British Portland Cement Association, the surface of silica sand particles being determined by their loss in weight in hydrofluoris acid. In the laboratory investigation the most important factors affecting the rate of solution such as acid intensity, temperature and diffusion, were kept constant so that the surface effect alone could be studied.

The results indicate that the rate of solution is directly proportionate to the surface exposed and hence inversely related to the particle size. In a number of instances it was noted, however, that the rate of solution of the grosser particles was greater than would be expected from theoretical considerations. The most logical place to look for causes for these differences is in the limestone themselves. As limestones are not pure chemical compounds nor yet pure minerals, we may expect chemical heterogeneity and various associations of minerals under carefully controlled conditions. Thus with limestones of considerable magnesium content, and this constituent is always present, we might expect a disintegration of the particle due to selective solubility of its constituent minerals rather than the regual solution as of a unit homogeneous particle. Just this thing was observed in several instances. A large particle in contact with an acid solution was seen to disintegrate into a number of smaller particles, thus offering new surfaces to the reaction. Since most of the material used for agricultural limestone in this state and elsewhere contains considerable amounts of materials other than calcium carbonate, it was thought advisable to gain some information on the association of these minerals and their effect on solution of the limestone.

In a limestone containing magnesium, this element may be present as the double carbonate of lime and magnesia or dolomite or may be disseminated through the material as the uncombined MgCO. As both occurrences have been cited by mineralogists the state of this constituent must be determined for the limestone under consideration. From the optical properties such as the index of refraction one would be led to believe that the association of these minerals is analogous to solid solution. Increments of one constituent in the other would have a regular progressive effect. It has been observed that an increase in the index of refraction follows quite closely the increasing content of magnesium in a limestone. However, in this association down to the unit particle, one would expect little if any selective solubility to be observed, since the intimacy of association would suggest simultaneous solution. This selective solubility has been encountered frequently in this investigation and of such definite extent that its possibility cannot be doubted. Let two examples suffice to illustrate this point. Weighed samples of a high magnesium limestone were subjected to successive acid washes, equivalent quantities of 0.205 N. HCL and of 0.0501 N. HCL being used. At definite time intervals the solutions were filtered and the residues returned to another portion of the original solution. The successive washes were analyzed for their content of $CaCO_3$ and $MgCO_3$, with the following results:

Solution	$\frac{CaCO_3}{MgCO_3}$ ratio	$\frac{CaCO_3}{MgCO_3}$ ratio
A	2.289	2.509
B	1.641	1.563
C	1.495	1.253
D	1.297	1.255
E	0.898	1.178
Combined	1.487	1.269
Original	1.256	1.256

In another case the materials examined were suspended in baskets made of glass rods constructed so that the particles smaller than 10 mesh could fall through. In the bottom of the beaker was a mixture of carbon tetrachloride and ether into which the particles formed by the disintegration of the larger pieces could fall and escape further solution. The solvent again was dilute HCl, 1.10 N. Upon analysis of the solution and the residue which was caught in the organized liquids below, these values were obtained:

Ratio of $\frac{CaCO_3}{MgCO_3}$ in	Solution	Residue	Original
	5.019	1.201	3.47

It is hardly surprising that definite breaks in the solubility curves were apparent. The solution of the more easily soluble cementing material freed the less quickly soluble constituents to pass into solution at their own rates. In several cases, microscopic examination revealed the presence of iron in the form of pyrite. It was rather surprising to note that in the presence of considerably larger quantities of $CaCO_3$ and $MgCO_3$ which we usually consider much more readily soluble than pyrite, this iron compound dissolved to such an extent that appreciable coatings of ferric hydroxide were formed at the surface of the limestone particles. It is not improbable that a limestone quite high in iron or alumina in a soluble form may become so coated by the precipitation of these as hydroxides as to protect the particle from further solution. In the soil where diffusion is particularly slow and the products of reaction cannot move away rapidly, this effect may be expected frequently.

The method suggested by Karsten and modified by Vesterberg for determining the calcium and magnesium minerals in a limestone is as follows: a portion of the sample passing 150 mesh is subjected to a 25 per cent excess of a 1 per cent acetic acid solution at temperature from one to three degrees C. for some time. The dolomite and magnesite are so much less soluble than calcite that a fairly quantitative separation is made. However, some solubility of the magnesium minerals takes place. The solubility of these is slower rather than lower, as is the case with most magnesium minerals in comparison with similar calcium compounds. When applied to the limestone in this study the test revealed differences in the combinations of the associated minerals, the more common being in the form of dolomite as an impurity in the limestone, rather than the occurrence of $MgCO_3$ alone. As a basis for the time for which a sample was to be left in contact with the cold acid, pure calcite was run simultaneously and the reaction was taken to be complete when the calcite had all dissolved.

Since the limestone treatment of the fields and plots in this problem had been made on the basis of supplying half the total limestone requirement during the first year, a number of limestones were examined for their solution rates where the solution was reduced to half its original strength by the solution of the sample. The solution which was chosen for this study was a 0.150 N solution of Hcl to which had been added enough calcium acetate to make the solution approximately .2 N. to this salt. During the run the change in pH was usually about .50 pH.

The apparatus consisted of a six liter flash immersed in a constant temperature water bath, both flask and bath being provided with stirrers adequate to keep liquid and solid particles therein in fairly uniform distribution. A quantity of the HCL solution was measured into a flask, to which was then added a sample of limestone sufficient to neutralize one-half the total acid present. At definite intervals, timed with a decimal stopwatch, portions of liquid and solids in suspension were drawn from the flask with reduced pressure and filtered quickly through a small Buchner funnel into a 250 cc. graduated flask. This portion was then titrated against standard NaOH solution with phenolphthalein after the solution had been heated to just 95 degrees C. to expel most of the CO_2 present. From the amount of acid neutralized in a given time, the rate of solution under these conditions was determined for separates and composites made of these separates. As the solution remaining in the flask after the withdrawal of the 250 cc. portions was unchanged by this process, it was possible to follow the solution through a completion for each sample taken.

The method proved to be very adaptable to the matter in hand and offers itself as a convenient means of determining the relative solubility of an unknown limestone in terms of known materials. The disturbing effects of diffusion, temperature change, etc., have been cared for as in the previously described method. The behavior of a limestone under these conditions may be used predicting its action in the field, at least as far as relative values go. In a series of pot experiments, the ability of a limestone to correct the soil acidity under normal conditions was found to accord quite well with its solubility rate in the laboratory. The experimental work is at present being carried on by Mr. Lilburn Allen, special attention being given to the problems of diffusion in the soil. While the major project is still unfinished certain conclusions are indicated so strongly that they may safely be pointed out here.

The rate of solution of a particle depends upon its surface area. In regularly shaped particles the total surface exposure of a given weight of material is inversely proportional to the diameters or linear dimensions of the particles. Hence, dividing the diameter of a particle by two, doubles its surface area and doubles its rate of solution.

Since any limestone has characteristic fracture and cleavage habits, it may be assumed that these habits will persist through all sizes to which the limestone may be reduced by crushing. Under these conditions the shape of the particles during crushing will be generally similar. Therefore, a definite relation should exist between the surfaces and the diameters of irregularly shaped particles of this material.

It was found in this investigation that the relation between the decrease in size and the increase in surface of irregularly shaped particles of limestone upon crushing is a constant one. It was found, further, that the rate of solution of limestone particles in dilute acid media is inversely related to the particle size. In the soil the same relationship was found to exist between the various sizes of limestone and their rates of becoming available. The rates of solution of all sizes were materially reduced because of the slowness of diffusion in the soil.

In general, the results obtained under field and laboratory conditions in this investigation support the original assumption that the rate of solution of limestone particles is inversely related to their diameters. The rate of solution of limestone in acid media is specific for that limestone. The physical properties, such as crystallinity and hardness, do not indicate the specific solution rate of a limestone. The rate of solution of limestone is affected greatly by its composition, especially by its content of magnesium carbonate. In general, the higher this content the lower the solution rate, but not in direct proportion to the $MgCO_3$ content. Certain exceptions to this general statement were found. One dolomitic limestone containing 23 per cent $MgCO_3$ was found to dissolve more rapidly during the first half of its solution than did practically pure calcite and other limestones of high calcium content.

In this investigation the dolomitic limestones observed were shown to be mixtures of the double carbonate of lime and magnesia ($MgCO_3$. $CaCO_3$) and $CaCO_3$. As the solution of the more quickly soluble $CaCO_3$ takes place the residue becomes enriched in its $MgCO_3$ content. Under the microscope the residues from the partial solution of dolomitic limestones were found to consist largely of well defined crystals, showing little solution effects. The index of refraction of these almost unaltered crystals was found to be 1.68 corresponding to dolomite.

The dolomitic limestones were observed to disintegrate in dilute acids into smaller particles, thus offering new surfaces to solution. As a result, the rate of solution of the larger particles of such limestones was somewhat greater than was to be expected from their size. In the soil this disintegration during solution was not observed. The compacting of soil particles about the limestone particle would tend to prevent disintegration. Fineness of division is more important to magnesian limestones than to those of high calcium for purposes of correcting soil acidity, quickly, because of the slower solubility of the magnesian material. Greater leaching losses occur from applications of high calcium limestones than from those of high magnesium content.

The time required for the complete disappearance of a 48-65 mesh particle of high calcium limestone under these conditions was approximately two years. The time required for the high calcium composites to neutralize one-half the limestone requirement under these conditions was eighteen months and two years. These applications had been made on the basis of the neutralizing effect of the 48-65 mesh particles. Hence, the rates at which these composites become available are in agreement with the calculated values.

The effects of the high calcium limestones separates under the same conditions vary from 42 per cent in the 4-6 mesh material up to the desired value in the material finer than 48 mesh in two years. The effect at the end of two years of 48-65 mesh high calcium limestone applied to satisfy the full limestone requirement is four times as great as that of the same material applied to satisfy only one-fourth the total requirement. Under the same conditions a full application of 48-65 high magnesium limestone satisfies only three times as great a requirement as does a one-fourth application.

The full application of 48-65 mesh high calcium material showed 80 per cent efficiency at the end of two years while high magnesium limestone showed 40 per cent. At the end of three and one-half years, however, the high calcium efficiency fell to 66 per cent while that of high magnesium stone rose to the same value and continued to increase. On farm plots with different soil types different responses are noted to the same limestone applications. The results which have been presented from small plot, pot, and laboratory studies show that the rate at which limestone becomes available in the soil can be predicted with fair accuracy from a knowledge of the screen analysis of the material used.

Various Stains Removed From Marble by Bureau of Standards

Continuing the study of means for removing various kinds of stains from marble work the Bureau of Standards, Department of Commerce, has developed methods for removing oil stains, copper stains, fire stains, wood stains, and the common service stains sometimes called the "yellowing" of marble.

Linseed oil and lubricating oil stains may be removed by a mixture of acetone and amyl acetate. Old oil stains which have turned yellow can sometimes be effectively bleached with hydrogen peroxide. Copper stains from bronze statuary on marble pedestals may be removed by a poultice made of powdered talc, ammonium chloride and ammonia water. Fire stains due to pine wood burning in contact with the marble can usually be removed with a mixture of trisodium phosphate solution and chlorinated lime by keeping a layer of saturated cotton over the stain for several days.

General service stains which are usually an accumulation of various kinds of discolorations on marble that has not been maintained in a proper state of cleanliness, can usually be removed by applying a poultice of powdered talc reduced to a pasty consistency with the trisodium phosphate and chlorinated lime solution. In treating stains on marble the active solvent is usually applied either in the form of a poultice by mixing it with an inert powdered material or by keeping a layer of cotton over the stain saturated with the solvent. In the case of very volatile solvents the saturated cotton may be covered with a scrap slab of marble.

FIELD TESTING OF CONCRETE FOR ROADS

By H. F. Clemmer
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THERE has been much consideration given by specification writers as to whether or not it would be more satisfactory to merely require that concrete attain a certain strength, rather than to require that the materials of which it is to be made meet fixed limits and to require that definite procedure be followed in the manufacture of concrete. In general, rigid specifications are made regarding the materials used and the methods of construction, with the supposition that if these requirements are followed, a satisfactory quality of concrete will result. This conjecture is based upon investigations and experiments which have been carried on under laboratory practice. However, it is fully realized that the careful control which may be exercised in the laboratory is not always possible in the field, and it is of utmost importance that field tests of the completed construction be made to determine whether or not similar results are obtained under field conditions as are obtained in the laboratory, and upon which the design is based.

Many of the requirements which have been considered necessary under the specifications for aggregates have been found of little importance and, in some cases, should be quite the reverse. The specifications for stone state that the materials should be clean, hard, strong, durable, etc., and it was thought especially essential that the stone be very hard to be most satisfactory for the manufacture of concrete for pavements.

In the Middle West where the softer limestones predominate, necessity made this a very important problem. Investigations show that greater cross bending strength in concrete may be developed with a stone having as high a percentage of wear as eight, rather than with a stone having as low a percentage of wear as three. The softer stone would generally show higher percentage of absorption and thereby develop a greater bond with the mortar. It may be possible, too, that this ability to absorb allows the stone to take up the moisture in the concrete while being mixed and assists in curing by giving up the moisture when the cement needs it for more complete hydration.

Inspection of materials and proper supervision of construction have reached a very high degree within the last few years, but the field testing of concrete permits an investigation to determine the value of the requirements which are specified for the materials and the methods of construction which include the placing and the curing of the concrete. In many of the committees working on specifications of materials, the question arises as to whether tests should be based on the quality of the resultant concrete made from the materials, and requirements as to the materials should not be placed in the specifications which are not needed for the improvement of the concrete. We should have tests and specifications as to materials which indicate that the materials are satisfactory for use, but many of the present tests are not satisfactory. Field testing will help to a great extent in showing what qualities and tests are of real value. Too, we are very careful regarding certain parts of our inspection but allow the value of this inspection to be lost due to other factors in the construction. Again field testing will be a big factor in checking our inspection which is carried on during construction.

Most of the investigational and experimental data which has been obtained in the past concerning concrete materials has dealt with the compression tests. Field testing of concrete pavements has consisted of drilling cores from the completed pavement or of making cylinders of the concrete used, both of which have been tested in compression. It is questionable whether this compression test gives as uniform a test as the transverse test, and it has been proven very definitely that the relation of cross bending to compression is not a constant and inasmuch as the modulus of rupture or transverse strength is used in the design of pavements, it is important that the strength of the concrete used be determined in this manner, and it is equally important to determine whether or not the requirements now placed upon aggregates are such as to insure material which will help to produce concrete for pavements with the greatest transverse strength.

In a study of design of pavements during the Bates Road Tests in Illinois, it was early realized that the transverse strength rather than the compression strength was the controlling factor, and therefore subsequent laboratory experiments were carried on with beams as specimens which were tested in cross bending. As a result of these investigations, a simple test, in which the specimen was held as a cantilever beam, was developed. This method of test has been very satisfactory for laboratory practice and has proven particularly applicable as a field test.

The testing machine consists of an extension arm which may be fastened to the free end of a specimen beam which is held in cantilever. The load is then applied by pouring some free running material at a uniform rate into a container which is fastened to the end of the cantilever arm. By this method a uniform application of load is made

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possible, and further, more than one break may be obtained for a check. Exact coincidence of results is not uncommon with the use of this machine while results on the same specimen rarely vary over small percentages. This simple method of test has made possible field testing which requires little labor and expense and gives results which are directly indicative of the true strength of the pavement concrete.

For this purpose test beams, approximately 6 x 6 x 30 inches are made in forms from the same mix as used in the pavement. These specimens are allowed to cure under the same conditions as the pavement concrete and are broken at regular intervals in the field with this simple testing device. The specimens may be held in cantilever by clamping to the rear end of a truck or other improvised platform. The loading medium can be water which may be measured and the load thus determined so that scales will not be required on the job.

A very satisfactory framework for holding the specimens and by means of which the load may be applied and measured with a dynamometer has been devised by the Testing Department of the Minnesota Highway Commission. This machine has proven both convenient and satisfactory for use in the field. Care should be used to be sure the dynamometer is properly calibrated, and that the load is uniformly applied so as not to cause the effect of impact or fatigue while testing.

The advantages of this test as compared to the former method of determining the compression strength are:

1. The saving in cost and time, as the apparatus necessary to make the test will cost but a few dollars and may be assembled in the field.

2. The method will give more uniform results due to the manner of testing.

3. The specimens may be tested in the field and therefore the concrete is tested under exactly the same conditions as those existing in the road slab.

4. The cross bending strength is determined rather than the compression strength which is not necessarily indicative of the cross bending of the concrete, and which is the manner in which concrete pavements fail.

In the construction of pavements, we often times find that the pavement is failing. It is almost impossible to find what is the cause for the poor concrete. I know of a recent case in which the pavement had been on for some six months and began to show failure by cracking and by surface deterioration. It was first thought it might be due to a little frosting, as the pavement had been laid in the fall of the year. Then the materials came under question and even the water. It was finally found that there was a lack of cement and that was the probable cause for this failure. Had they been carrying on the tests as they were constructing the road and making the determination in four, six and eight days, they would have found they did not have the proper strength at that time and would have been able to correct that trouble rather than complete the road and find it out afterwards.

This method of making tests in the field has proven of particular value in determining when pavements may be opened to traffic. In the past engineers have specified an arbitrary length of time for the curing of concrete pavements before opening to traffic, not taking into account the fact that all concrete does not gain strength at the same rate. With the results of these tests which are made to determine the strength of the concrete as it actually is stressed under service, the engineer may know definitely that sufficient strength has been attained by the concrete before traffic is allowed to use the pavement.

In general, where this method of field testing is used and the pavement opened to traffic as determined by these results, the public will be permitted to use the road much sooner than has been the custom in the past, as the arbitrary length of time set for curing is in most cases much longer than is necessary for the proper curing of the concrete, although in some cases when curing conditions are unfavorable, such as during the fall months when the temperature is low, the concrete does not gain proper strength in the time allowed.

In many cases pavements have been opened to traffic in less than seven days and even in as short a time as eighty-nine hours, consideration having been given to the nature of the traffic which would use the road, while it is generally recommended the pavement be kept closed for at least fourteen days unless tests are made to be sure proper curing has taken place. Many highway departments now state the strength which must be attained before the pavement may be opened rather than specifying an arbitrary length of time for curing.

It is particularly difficult to determine the cause for poor concrete after it has been placed and allowed to cure. It may be due to freezing, lack of cement, poor materials or any number of conditions. However, if field testing is carried on in the manner stated above and tests made at an early date, the fault may be corrected at once rather than to allow the entire construction to be completed before final tests are made and when it is very difficult to learn the actual construction conditions. Too often pavements show excessive deterioration after short service and upon testing cores drilled from the slab, it is found that the concrete is of low strength. It is not only then very difficult to determine the cause and on whom to place the blame for the poor concrete, but the entire job has been affected, while if the testing had been carried on during construction and in the field under the same conditions as pertained to the pavement slab, it could have been corrected at once.

This method of testing may be used very advantageously in connection with general concrete construction as the results of the tests will indicate when it is safe to remove forms and when the concrete has gained sufficient strength to withstand loading. It is particularly valuable when construction is being carried on during low temperatures. If the specimens are given just the same protection as the concrete being poured, it is safe to assume that the concrete will gain at least equal strength to that shown by testing the specimens. Many costly failures have resulted from removing forms from concrete too soon.

The most important test is one which gives results showing the value of material under the actual conditions to which it is subjected. There should be methods of tests to determine the quality of certain aggregates for concrete and definite limits set regarding these requirements, but if these tests are to be of real value it must be possible to check their results with the results of actual field tests made under the same conditions as those to which the concrete is subjected. I believe this simple cantilever method of testing in the field is of particular value in this connection. A correlation of field data obtained by this method with laboratory tests made on materials used will offer opportunity to study the present specifications imposed upon aggregates for concrete.

EXPANSION IN THE PORTLAND CEMENT INDUSTRY

Discussing the American Portland Cement industry in the February issue of Commerce Monthly the National Bank of Commerce in New York points out that substantial additions to present plant capacity will tend to produce excessively competitive conditions necessitating a period of readjustment.

"With the initiation of the postwar building boom Portland cement manufacture resumed the steady expansion that had characterized twenty odd years of its existence prior to the outbreak of the war in 1914. Large as was its capacity at the beginning of the boom and rapidly as it was increased, the industry was taxed to keep pace with the growth in demand. Four years of construction, however, has restored the normal surplus of capacity over requirements. As the rise in consumption appears to have lost its upward momentum it seems likely that present cement-manufacturing facilities, with equipment now in process of installation, are entirely adequate to handle the probable demands of the next few years.

"The always generous surplus of capacity above requirement does not seem to denote a very close adjustment between supply and demand. As a matter of fact certain characteristics inherent in the industry make it peculiarly subject to overexpansion. The product is heavy and bulky while its value is relatively low. Freight rates, therefore, are an important element in cost to consumers, and in relatively distant markets they form a protective barrier that becomes a powerful incentive to the establishment of local plants. Thus with an almost universal occurrence of suitable raw materials the course of cement manufacture has been marked by progressive geographic decentralization.

"For the industry as a whole the final result is a certain amount of unused capacity since it may be stated as a general rule that all parts of the country are never uniformly prosperous at once.

"This tendency toward excess capacity is accentuated by the pronounced seasonal movement of demand. Road building generally comes to a stop in the winter months and building activity slows down.

"The problem presented by the greater requirements in the good weather months resolves itself into striking a balance between equipment enough to handle the entire peak demand and building up sufficient stocks in the off season to care for any possible developments. As cement, through its liability to damage from moisture, requires expensive storage facilities and there is a certain market risk in building up large stocks, the solution has seemed to lie in normally maintaining some excess equipment to handle a part of the peak requirements.

"Under these conditions a surplus of potential output over actual production is not an abnormal state of affairs. In the past, demand engaging in the neighborhood of 85 per cent of the facilities available has sufficed to raise prices and attract imports.

"On this basis the rate of activity in the years 1923 to 1925 must in general be considered highly satisfactory—in fact the most fully employed interval since 1907. In 1923 the industry was called upon to utilize nearly 90 per cent of its potential output. The rate of operation was but little lower in the two succeeding years, yet there was no indications of excess production.

"In summary, it does not appear likely at present that there will be continued large increases in cement consumption in the next few years. The requirements of the country, however, should approximate the levels lately attained unless unfavorable developments in business interfere. Demand as illustrated by the total of shipments in 1926 is sufficient to engage the estimated facilities at the end of this year to about 81 per cent of capacity. Additional equipment to be ready in 1927 will reduce the rate of operation to between 75 and 80 per cent. It is apparent, therefore, that if prosperous conditions are to be maintained in the industry and if a return to excessively competitive conditions is to be avoided it is imperative to slacken the rate at which capacity to produce is being enlarged."

VALUE OF SAND AND GRAVEL TRAFFIC AS REVENUE TO THE RAILROADS

By Edwin Brooker*

THIS subject, when considered from a transportation standpoint, is very interesting not only to the producers but to the railroads as well, and a knowledge thereof by all parties, is essential if producers are to maintain or secure that level of transportation charges which will reflect no more than a proper contribution to the revenues of the carriers.

The litigation before the Interstate Commerce Commission and the various state Commissions during the past several years, may be blamed to a large extent, upon those in charge of making the carriers' freight rates, chiefly because of a lack of knowledge of the value of these commodities as revenue producing traffic.

I am safe in making this statement because it is based on my own attitude towards these commodities, during my former connections with the carriers, as well as a knowledge of the feeling of other railroad men, through my past associations with them in the making of rates.

One of the chief factors, responsible for such an attitude in years gone by, was the fact that railroads formerly gauged their revenues by the ton and ton mile and not by the car or car mile.

I began to see the light back in 1915 after serving 15 years with the railroads and since then, fully 75% of my work has consisted of the representation of sand, gravel and crushed stone producers in traffic and transportation matters and I have never passed up an opportunity to place before the carriers and governmental authorities, facts, which conclusively prove, when railroads' operating costs and gross revenues are taken into account, that sand, gravel and like commodities are among the most desirable traffic handled by the railroads.

In the consideration of this subject, we must look at the facts from two angles. We must first consider the favorable transportation characteristics which speak for low operating costs and then consider the revenues derived from these materials.

The favorable transportation characteristics of these commodities, which speak for low operating costs, are, the nature of the traffic and its value, which enter into the character of the risk and the liability of the carriers in the handling thereof, and the density of the traffic and heavy loading, which reduce the operating costs per ton.

When cars of sand and gravel and like commodities are delivered to the railroads for transportation, they are handling materials of extremely low value. So low in fact that in numerous cases the freight charges thereon exceed the value of the traffic. These commodities are not subject to damage from any of the elements. We hear of occasional losses but in such cases it is due to defective equipment or in the case where the car is in a wreck. Even then the material is not damaged and the carriers salvage the same and use it for ballast. Rough handling by the carriers do not damage these materials. We must arrive at the conclusion, that the carriers assume no risk or liability in the handling of these materials and the claims for losses are so negligible that they are not even given a classification in the claim records of the railroads.

Compare this situation with that applicable to other commodities. Look at the value of a carload of livestock and the care which must be given in the handling thereof. Look at the value of grain and grain products and its liability to damage and loss. Take even coal which is subject to a great amount of pilferage and numerous other commodities which must be protected from the weather and given expedited service. A certain amount of the carriers gross revenues received from the transportation of other commodities are used for the payment of claims for loss and damage to such traffic.

No deductions from gross revenues are necessary to cover claims for loss or damage to sand, gravel or crushed stone. They require no expedited service or especial care in the handling and with the assumption of no risk or liability, they must from this standpoint be considered as desirable commodities.

Sand, gravel and crushed stone are generally transported in open top cars, the cheapest type of railroad equipment. We all know that the car is the unit of transportation. It represents a unit of investment upon which charges for interest, taxes, depreciation and repairs are computed, and which are items forming a part of railroad operating costs. Throughout the process of billing freight, maintaining car records, accounting and service performed, the car is the unit. Irrespective of the kind of traffic loaded into a car, there are certain fixed items of expense chargeable to each car to cover interest on investment, depreciation, taxes, repairs, billing, accounting and the keeping of necessary records of car movements. It is true that this charge may differ according to the various types of equipment, but open top cars in which sand, gravel and crushed stone are transported,

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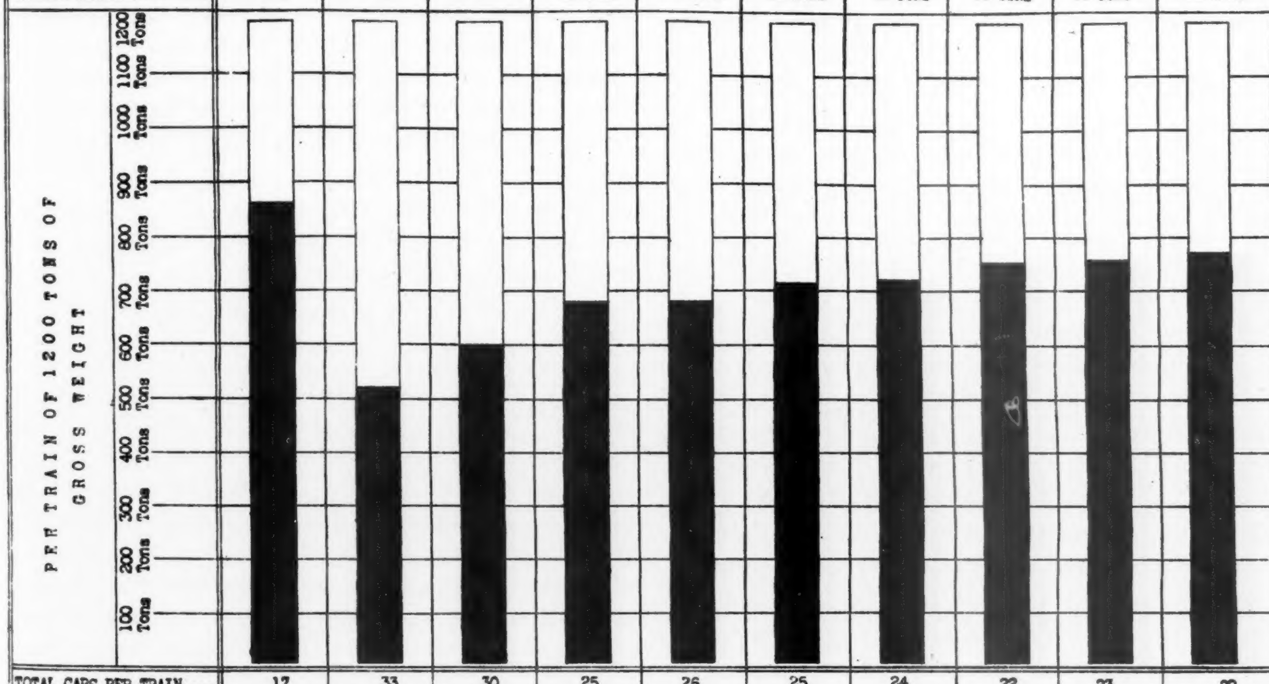
represent the type with the lowest investment and consequently have the lowest fixed charges for interest, taxes, depreciation, etc., chargeable against the car.

The weight of the individual car averages about 20 tons. This weight of 20 tons represents dead weight which the railroads must transport whether the car is loaded or empty. All engines are rated according to their hauling capacities in the various localities. In making up the hauling capacity of the engine, or what we might term a trainload, the weight of the car itself is an important factor. The gross weight of a carload of freight which combines the weight of the car plus the weight of the freight, is what determines the number of carloads which makes up a trainload.

There is where the heavy loading of sand, gravel and crushed stone is an important factor. The average loading per car of these commodities is in excess of 50 tons per car. I have found average loadings in particular territories to run as high as 59 tons per car. Using an average loading of 50 tons per car and adding to it the weight of the car itself, we have a gross weight of 70 tons per car. In order to illustrate the point I have in mind, let us use as an example, an engine with a hauling capacity of 1,200 tons. Such an engine can only haul 17 cars loaded with sand and gravel of 50 tons, with a gross weight of 70 tons per car. In these 17 cars at a 50 ton loading, there is 850 tons of revenue paying freight and the remainder of the weight to make up the 1,200 tons which is the engine capacity, is dead weight to cover the cars used. Seventeen cars weighing 20 tons each represents a dead weight handled of 340 tons. The costs of handling a trainload of sand and gravel with a gross weight of 1,200 tons is distributed among the 850 tons of revenue freight.

To go to the other extreme let us consider the situation with respect to the handling of a train-

BASED ON DISTANCE OF 100 MILES.



COMMODITIES............	SAND AND GRAVEL	HAY & STRAW	SAW LOGS	SCRAP IRON	SHINGLES	STRUCTURAL STEEL	LUMBER	LIME	FERTILIZER	EXCELSIOR WOOD
AVERAGE LOADING.........	50 TONS	16 TONS	20 TONS	25 TONS	26 TONS	28 TONS	30 TONS	34 TONS	33 TONS	35 TONS
TOTAL CARS PER TRAIN....	17	33	30	25	26	25	24	22	23	22
TOTAL TONS DEAD WEIGHT..	340	678	600	525	524	500	480	452	441	430
TOTAL TONS REVENUE FRT..	860	528	600	675	676	700	720	748	759	770
FREIGHT RATE PER TON....	$1.25	$1.90	$1.75	$2.00	$2.20	$2.80	$2.20	$2.00	$1.25	$1.10
VALUE PER TON..........	$0.80	$12.50	$15.00	$7.00	$23.00	$43.00	$25.50	$15.00	$47.00	$4.30
FREIGHT REVENUE PER CAR.	$62.50	$30.40	$35.00	$50.00	$57.20	$78.40	$66.00	$68.00	$41.25	$38.50
VALUE PER CAR..........	$40.00	$200.00	$300.00	$175.00	$600.00	$1120.00	$770.00	$510.00	$1650.00	$150.00
FRT.REVENUE PER TRAIN...	$1075.00	$1003.00	$1050.00	$1350.00	$1487.00	$1960.00	$1584.00	$1496.00	$ 948.75	$847.00
VALUE PER TRAIN........	$ 688.00	$6600.00	$9000.00	$4725.00	$15000.00	$30100.00	$5610.00	$11220.00	$18365.00	$3311.00
RELATIONSHIP OF TERMINAL SERVICE BASED ON NUMBER OF CARS PER TRAIN.......	100.0%	194.0%	176.[illegible]%	147.1%	152.9%	147.1%	141.2%	129.4%	135.3%	129.4%
RELATIONSHIP OF ROADHAUL SERVICE PER TON BASED ON TONNAGE HANDLED......	100.0%	162.8%	143.3%	127.4%	127.2%	132.8%	119.4%	114.9%	113.3%	111.7%

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load of livestock and their products, which according to Interstate Commerce Commission reports for the year 1925, had an average loading of 12 tons per car. Again taking 20 tons as the average weight of the car and the average loading of livestock and its products of 12 tons per car, we have a gross weight of 32 tons per car. An engine with a capacity of 1,200 tons can haul 37 carloads of livestock, 37 carloads with an average loading of 12 tons per car, represents only 444 tons of revenue paying freight out of 1,200 tons making up the trainload. Considering the roadhaul train service only, it certainly does not cost any more to handle a trainload of sand and gravel with a gross weight of the train, 1,200 tons, than it does to handle a trainload of livestock with the same gross weight of 1,200 tons. In the case of sand and gravel it only requires 17 cars whereas with livestock it requires 37 cars. Consider the investment of money in those 37 cars loaded with livestock as compared with 17 cars loaded with sand and gravel. Consider the interest on the investment in the two cases, the allotment for taxes, depreciation, repairs, etc. Please bear in mind that the terminal service was performed on 37 cars in the one instance as compared with terminal service on 17 cars. In the weighing of the cars, 17 cars of sand and gravel as compared with 37 cars of livestock. In the billing of the cars, maintaining car records, and accounting, the work performed on 37 cars of livestock as compared with the work on 17 cars of sand and gravel.

Following this line of reasoning further and keeping in mind our trainload with 1,200 tons of both kinds of traffic, we have in the instance of sand and gravel, 850 tons of revenue paying freight and in the instance of livestock, only 444 tons. Suppose we apportion the actual costs of handling a train with a gross weight of 1,200 tons among the 850 tons of sand and gravel and do the same thing with 444 tons of livestock. We have almost twice the cost per ton on livestock as we do on sand and gravel and that does not take into account the difference in the investment, interest, taxes, depreciation, terminal service, weighing, billing or accounting on 37 cars as compared with 17 cars loaded with sand and gravel.

We must also consider the value of 37 cars of livestock making up a train load, as compared with the value of 17 cars of sand and gravel. The risk and liability of the carriers in handling livestock is enormous. Such traffic must be handled with great care and given expedited service. Again I repeat, sand and gravel are commodities of low value, require no expedited service upon which the railroads assume no risk or liability in their transportation. The same ratio of costs of handling sand and gravel as compared with livestock in train loads, would apply to individual cars because in the one instance, when using a car we have 50 tons of revenue paying freight, and in the other car 12 tons of paying revenue freight.

Transportation service is divided into two parts, the road haul movement and terminal service which precedes and follows road haul. Every shipment receiving a road haul must have terminal service performed at origin and destination, and while the road haul costs on a particular traffic will differ, based on distance hauled, you will find the same general terminal cost applicable to a particular traffic; irrespective of the distance of the road haul movement.

It is true that the cost of handling traffic in road haul movement, increases with distance hauled, and as between long haul traffic and short haul traffic, you will find greater costs for the long haul traffic per mile, because of the intermediate terminal service required on cars passing through division points.

Sand and gravel traffic is normally short haul traffic, requiring very little intermediate terminal service. The railroads receive a quick turnover on their cars. There is a minimum of car detention at the loading plants, as well as at destination because the commodities are easily loaded and unloaded. Some established plants can load a car with sand and gravel in 15 minutes, at other plants it will take longer. It is, however, the invariable practice that when cars are placed at a plant in the morning for loading, that the loaded cars are ready for delivery to the railroads that evening. From my experience in analyzing the various situations at sand and gravel plants, I can safely say, that the average car detention at all plants will not exceed 12 hours. On only rare occasions do producers detain cars at their plants for loading beyond the 48 hour free time allowed for that purpose.

I want to dwell for a few minutes on the terminal service performed at sand and gravel plants and this is where the density of the traffic plays an important part. It is common knowledge that in switching service, engines are not working to their full hauling capacity. Established plants have loading capacities of from 5 to 50 cars per day. The engine will take a string of empty cars from their yard and transport them to a sand and gravel plant for loading. They push this string of cars in on a plant siding, pick up all the loaded cars at the plant and return to the railroad yard. In some instances they will perform service at some other industries en route. When the loaded cars arrive at the railroad yard, they are weighed and then classified by placing them on different tracks, according to their destination. They are then ready for the road haul movement. In many cases they will be taken from the plants and delivered at their destination without any yard service.

The point I wish to make is, that the railroads in handling sand and gravel are not performing terminal service on individual cars, but are performing the service on a number of cars at the same time. Does it take any longer for a switching engine to pick up and transport 10 empty cars from their yards to a plant, than it does to perform the same service on 1 car? Does it cost them any more to place 10 empty cars on a plant siding than it does 1 car? Is there any difference in the service performed in picking up 5 or 10 cars of sand and gravel at a plant than the service performed on 1 car and how about the service in transporting such cars to the yard? The weighing costs, of course, would be the same on each individual car.

I say the difference in cost and service, if any, is very slight, and therefore, the engine hour costs in terminal service are prorated among more cars when sand and gravel traffic is handled, than when switching service is performed at industries, producing and shipping a lesser number of cars per day.

Here again, is where the heavy loading of these commodities is an important factor, because not only does the density of sand and gravel traffic moving from a particular plant reduce the railroad terminal costs per car, but such terminal costs per car, are distributed among at least 50 tons, while in the care of traffic with a lighter loading, such costs are distributed among a lesser number of tons per car.

Before I leave the subject of the desirability of sand and gravel from a carrier's operating point of view, I wish to call attention to a few traffic statistics taken from reports of the Interstate Commerce Commission for the year 1925. During that year the carriers handled 145,402,178 tons of sand, gravel, clay and stone, in the same year they handled 109,266,288 tons of agricultural products. It required only 2,883,917 cars to transport over 145,000,000 tons of our commodities, but it required 4,674,218 cars to transport a little over 109,000,000 tons of products of agriculture. In the one instance, in 8% of the total carloads handled, they handled 12% of the total tonnage handled, while in the case of agriculture in 13% of the total carloads handled there was only 9% of the total tonnage.

As compared with animals and other products, which includes livestock, meats, poultry, eggs, butter, cheese, wool, hides and leather, the carriers during the year 1925 handled 2,215,166 cars of such commodities as compared with 2,883,917 carloads of sand, gravel, etc. The tonnage of animals and other products, however, was only 26,223,862 tons as compared with 145,402,178 tons of our commodities. Products of forests, which include lumber, etc., is represented by about 1,000,000 more cars than sand and gravel, but the tonnage of forests products is about 38,000,000 tons less than sand and gravel.

Sand, gravel and crushed stone are desirable commodities to handle from a revenue producing standpoint and to prove this statement I must again resort to figures.

In the entire eastern district covering over 59,000 miles of railroad, the carriers handled approximately 1,204,000,000 tons of freight during the year 1925. The average haul in this traffic was 149 miles. For this distance the carriers' average revenue on all traffic was only $46.90 per car.

The average freight rate today on sand, gravel and crushed stone for a distance of 20 miles is about 60 cents per ton. This freight rate of 60 cents per ton at a 50 ton loading, gives the carriers $30.00 per car for distances of 20 miles and less. The average haul of sand, gravel and crushed stone is estimated at about 60 miles, and the average freight rate for that distance about 80 cents per ton. Such a freight rate returns to the carriers $40.00 per car on sand, gravel and crushed stone for an average haul of 60 miles. Take a rate of $1.00 per ton for a distance of 100 miles, sand, gravel and crushed stone will pay the railroads $50.00 per car while in the eastern district on all traffic for an average haul of 149 miles their revnue is only $46.90 per car.

In the Southern District with an average haul of 219 miles on all traffic, the average revenue per car for the year 1925 was $60.70 per car and in the Western District for an average haul on all traffic of 216 miles, the average revenue per car was only $62.67. The average haul on all freight in the United States for the year 1925 was 181.6 miles with an average revenue per car for that distance, of only $53.73.

If you take these average revenues on all freight per car of $46.90 for an average haul of 149 miles in the Eastern District, $60.70 for an average haul of 219 miles in the Southern District, $62.70 for an average haul of 217 miles in the Western District and $53.73 for an average haul of 181 miles in the whole United States and compare them with your freight rates for the various distances at a 50 ton loading you will see that the carriers' revenue on sand, gravel and crushed stone are exceedingly high as compared with the average revenues on all freight.

Then take into consideration the favorable characteristics of these commodities which speak for low operating costs, you will readily see why I have taken the position and still maintain that sand, gravel and crushed stone are paying more than their proper share of the transportation revenues of the carriers.

Sand, gravel and crushed stone traffic is generally short haul traffic, but it is made so by the high level of freight rates which, during the past few years, has caused a decentralization of the industry.

The gross and the net revenue received by the railroads for transporting sand, gravel and crushed stone traffic would be more at the prevailing rates than if that same car was engaged in the transportation of other traffic a greater distance and consuming the same period of time involved in the movement of two separate shipments in the same cars between short haul points.

It is unfortunate that no method has yet been discovered by which the actual operating railroad costs on a particular commodity can be ascertained. Continued presentation however, of these facts in litigation involving freight rates on sand, gravel and crushed stone as well as in the producers' negotiations with the carriers for the establishment of rates, will, in the end, place these commodities where they belong, in contributing no more than a just share of the transportation revenues of the carriers.

While producers have not had much difficulty with State Commissions to secure relief from high freight rates, at the same time it is only recently that we have been able to secure any recognition from the Interstate Commerce Commission with respect to these commodities.

In 104 I. C. C. 717 in the case of the Pennsylvania Sand & Gravel Producers' Association vs. The Baltimore & Ohio Railroad Company et al., the Interstate Commerce Commission said:

"Sand and gravel are among the lowest grade commodities known to commerce and cannot move except at low rates. They are transported exclusively in open top cars loading to and beyond the marked capacity of the car. Some plants load as high as 40 or 50 cars per day and the entire days' output is generally moved from the plant at the time empty cars are placed. An ample supply of cars is generally near at hand and loading is usually accomplished in 24 hours. The risk and liability of loss and damage is negligible. The movement is often in train lots and it is generally considered desirable traffic."

In that case the carriers computed their annual loss under the rates prescribed as being in excess of $614,000 and stressed this point in two positions which they filed for a reopening of this case. In both instances the petitions for rehearing were denied by the Interstate Commerce Commission.

The. Examiner in a proposed report in I. C. C. Docket No. 17517 which has not yet been decided, repeats these same principles and recommends the establishment of lower rates in the Southern Territory.

It would be my suggestion that the producers study these facts and statements carefully and never lose an opportunity to place them before the railroads in matters involving freight rates. By so doing they will be advancing the needs of the industry just as much as in their campaign of education for consumers to use clean and well graded materials, because, without just and reasonable freight rates on sand, gravel and crushed stone, they will always be hindered in the marketing thereof.

Masonry Committee To Recommend Adoption of Water Cement Ratio

The Masonry Committee of the American Railway Engineering Association, it is announced, will recommend that that organization adopt the "water-cement ratio" for proportioning concrete at its meeting **March 8-10.** The "water-cement ratio" is a law which states that within the limits of plastic, workable mixes the strength of concrete is inversely proportional to the amount of water per sack of cement used in mixing. In other words, the less water used, the stronger will be the concrete.

By using this law as the basis of specifications, engineers are able to design concrete of a definite compressive strength. With sound clean aggregates, a workable mix and proper curing, the concrete will have a specific strength for any given amount of mixing water per sack of cement. This fact makes it possible for engineers to secure concrete equal to or more than a specified minimum strength without using an excess of any material.

At present, many railroads are applying the "water-cement ratio" in proportioning concrete. Among these roads are: Atchison, Topeka & Santa Fe; Big Four; New York, Chicago & St. Louis; Pennsylvania; Canadian National; Chicago, Burlington & Quincy; Chicago & Western Indiana; Chicago, Rock Island & Pacific; and Hocking Valley.

Universal Gypsum and Lime Company Elects Four New Directors

Stockholders of the Universal Gypsum and Lime Company, at the annual meeting recently, elected Norman G. Hough, R. G. Rankin, C. F. Kaler and F. Krumholz to the board of directors to succeed W. A. Brewerton, Rodney Hitt, M. A. Johnson and Thomas Thorkildsen. At the meeting of the board two officers were added to fill newly created positions. Norman Hough was named as vice-president in charge of sales, and S. P. Cross was made assistant secretary. Stockholders will probably receive the financial statement for the year ended December 31 within the next week or ten days.

Free Lime in Portland Cement

The method consists of treating the thoroughly dry cement with 20 per cent glycerin in absolute alcohol and titrating hot with ammonia acetate solution with phenol-phthalein as indicator. The reaction is: $CaO + 2CH_3COONH_4 — (CH_3COO)_2 Ca + 2NH_3 + H2O$.

PIT AND QUARRY FOREIGN DIGEST

Recovery of Heat from the Gases Evolved Rotary Cement Kilns

Elaborate calculations allowing for all possible losses show that with the average rotary kiln, and using the most modern turbine equipment it is possible to obtain 90 kilowatt hours for each ton of cement produced by the transformation of the heat of the waste gases to electric power. In either the wet or dry methods recovery of the heat in the gases from the kilns will furnish sufficient energy to run the whole works. Rey (Le Ciment, Vol. 31, pp. 438-442. 1926).

Magnesium Cements

The first magnesium cement manufactured industrially was the Sorel cement which consisted of a mixture of calcined magnesia (magnesium oxide) and magnesium chloride. The magnesite is calcined at about 500 degrees C. for the very pure variety or at 800 degrees for material containing iron oxides. Too high a calcination temperature, 1,500 degrees, for example, gives a magnesia unsuited for magnesium cement. The powdered magnesia is mixed with diverse agglomerate such as saw-dust, asbestos, sand, cork, diatomaceous earth and mineral coloring matter. This is then mixed with a solution of magnesium chloride of 22 degrees baumé. The cement compares favorably with other paving materials for flagstone pavements. J. N. (Le Ciment, Vol. 31, pp. 443-445, 1926.)

Concrete Marine Buoys

At Finistére in France several buoys have been constructed of concrete during the past year. These were made of fused aluminous cement and averaged 20 to 25 ft. high and 5 ft. diameter with a base of 8 ft. in diameter set upon the rock and reinforced by 30 steel bars belicoidal in shape. The results so far have proven most satisfactory especially for the high calcium sulphate sea water around the French coast. Coyne (Le Ciment, Vol. 31, p. 445).

Action of Heat on Kaolin

It is known that kaolin decomposes at about 500 degrees and loses its combined water; after this dehydration it is easily soluble in acids. In addition natural kaolin always contains a certain amount of hygroscopic water which can be eliminated either by prolonged heating at 130 or very rapidly at 250 degrees. Four samples of kaolin were treated as follows: Three were heated for two hours at 250, 550-600 and 950-1000 degrees. The fourth was not heated. The samples were then tested for absorptive power with iodine and methylene blue solutions. In both cases the untreated sample showed maximum absorption with a graduating scale for the heated portions, absorption decreasing with increase in temperature of heating. With water and aqueous ammonia the absorptive power was substantially the same except that the sample heated to 250 degrees exhibited slightly greater values than the untreated. Rene Dubrisay (Paper read at Meeting of Academie des Sciences, November 3, 1926, and Le Ciment).

Influence of Electric Current on Cement

Passage of a direct electric current appears to diminish the strength of the cement. An alternating current seems to have no other influence than to accelerate the hardening by means of raising the temperature. It is thought that during the construction of any work, certain essential parts such as pillars, beams, etc., require a rapid hardening and this might be accomplished by means of an alternating currrent. It is suggested that this method of accelerating hardening be tried out on a practical scale. The treatment furthermore is valuable in the laboratory as it makes possible rapid testing of cement. Verdreau (Le Ciment, Vol. 31, pp. 451-2, 1926).

Use of Bituminous Schist

The schist contains as chief ingredients approximately 43 per cent silica, 16 per cent alumina, 6 per cent ferric oxide and 26 per cent carbonaceous material. The iron oxide causes the surface of the brick to become vitrified without otherwise affecting the quality of the brick. Those schists which are adjacent to the veins of coal are most available for brick making. The bricks must be burned at a high temperature, averaging 1,150 degrees C., and must be attended with great care. Bricks of this sort absorb only 1½ to 2 per cent of water and have an average strength of 16 lbs. per sq. inch. G. Coliez (Revue Industrielle and Le Ciment, Vol. 31, pp. 464-467).

Concrete Roads

The proportions recommended are 1,100 liters crushed stone, half of which have a diameter of 5 to 20 millimeters, half 20-40 millimeters, 450 liters of silica sand or other hard powdered material, 400 kilograms Portland Cement. Objections to concrete roads are long interruption of traffic, appearance of cracks, difficulty of digging ditches for piping and the difficulty and costliness of repairs. The advantages are, the surface is very smooth for vehicles, it has great resistance to flooding, the absence of dust and the long life of 15 to 20 years. J. Berenguier (Revue de L'Ingenieur).

Testing Setting Time of Cement

One or more galvanic elements which pass through the mass produced by a mixture of water and the cement to be tested are made of two conducting bodies of different materials such as copper and zinc plates and connected to a voltmeter where the setting time can be determined by the change in voltage as shown by the break in the recorded voltage curve. The known method of testing, by means of a standard needle or simply by pressure with the fingernail necessitates a series of tests for each measurement and in spite of this does not give exact data. The results of testing by this procedure are influenced by mistakes of the observer, and the value of the measurement depends upon the reliability of the tester. This deficiency is eliminated by this discovery. Siemens & Halske (German Patent 430,768).

Process for the Preparation of Fused Cement

The fused material from a rotating kiln flows into a side chamber by the shortest possible route, where it is mixed intimately with other materials and if necessary, reworked. A variation consists of making the side chamber and oven one piece by fastening them together in an air tight manner and in such a way that the fluid mass collects in the side chamber. In this chamber further heating can be applied to the mass or it may be subjected to a reducing agent. Fa. G. Polysius (German Patent 434,187).

Manufacture of Molded Pieces From Sorel Cement

The setting and hardening are accelerated by heat treatment, by heating the material in air tight molds and to a temperaturee of 180-220 degrees C. The importance of the process consists in the fact that it makes possible a continuous production of molded forms in molding devices, such as have previously been made only from fibrous sheets. Austro-American Magnesite Co. and K. Erdmann (German Patent 434,348).

Cements in Potash Liquors

Standard samples were prepared from blast furnace cement, iron Portland cement and Portland cement and were placed in the liquors and also in water for a year. It was found that cements with low lime content such as blast furnace cement are more resistant. Addition of trass increases the resistance. Coating with "Fluat" solution protects still further as the pores are partially filled with a deposition of fluorspar. Calame (Kali, Vol. 20, pp. 328-36, 1926).

Time and Structure

What happens to the reinforcing bar at the point where haircracks have been developed in the surrounding concrete is a problem for the future to decide, though it is extremely probable that such points will be found to be sources of weakness not only on account of attack by moist and acid air but because the loss of rigidity in the concrete means the concentration of repeated bendings in these parts of the bar under variations of strain consequent upon variations in the loading scheme that must take place as the building is subjected to different uses and to different wind pressures. To build a dam that will stand absolutely from age to age is not within the bounds of possibility, for the bursting pressures of the water can never be effectively resolved into an absolutely central load on the foundation, and where the stresses are severe in proportion to the strength of the material, the least eccentricity of the application of the load produces rocking movements.—W. Harvey, (The Structural Engineer, Vol. 10, p. 5-11, Jan., 1927).

Aesthetics of Concrete Construction

It is the great tradition of engineering that engineers should claim to be not only constructors but artists, and that they should also realize that there is a distinction between the construction and aesthetic function. If at the present day a certain number of engineers deny this distinction and seriously believe that if a building be only well constructed it is also beautiful, this is because they have allowed themselves to be interested by a school of architectural doctrinaries who are never tired of propounding this particular fallacy and who, having already done much to corrupt the practice of architecture would now also corrupt that of engineering. Precisely how much of what is vulgar and incompetent in the design of buildings is directly due to the influence of those who preach this doctrine, it is, of course impossible to say, but there can be little doubt that their power has been considerable. —A. T. Edwards (The Structural Engineer, Vol. 5, p. 13-18, January, 1927).

Concrete Surface Treatment

Excellent effects are obtained in making concrete surfaces resemble natural stone by the following methods: Concrete made of crushed Portland stone and tooled to a ribbed finish, aggregate of marble chippings finished to a smooth surface by rubbing, crushed granite chippings left slightly rough by the chisel, concrete figures roughly molded and then finished by hand treating the surface of special aggregate so as to remove the cement film by water or acid.—Anon. (Concrete and Const. Eng., Vol. 21, 793-798, 1926).

SOME METHODS OF ELIMINATING HAZARDS IN OUTSIDE SHOOTING

IN AN article in the January issue of the du Pont Magazine, Mr. Charles Hurter, one of the company's technical representatives, discusses for the benefit of blasters, some methods for eliminating common hazards in outside shooting. The article deals principally with the problem of misfires. In this connection, Mr. Hurter says: "Misfires are about the most serious source of danger involved in any kind of blasting. Hence every precaution should be taken to avoid them. The possibility of a misfire is greatly reduced if more than one detonator is placed in each hole. With electric blasting caps, one set need not be connected in the circuit but simply left as a reserve in case only a limited amount of electric power is available.

"A frequent cause of misfires, especially misfires of center holes in a long line, and in particular in the presence of certain earthly salts in the ground water, has been leakage of electric current. Even minute traces of some earthly salts in solution will increase the electrical conductivity of the ground enough to cause excessive current leakage from the wires of ordinary electric blasting caps. The only sure way to prevent misfires where such salts are present in solution is to use electric blasting caps with enameled wires. The enamel on the wire under the cotton winding provides extra insulation.

"Waterproof electric blasting caps are regularly made with enameled wires. I have seen cases where it was necessary to use waterproof caps on what would be called dry work. In fact, the problem of current leakage makes it necessary to limit the number of ordinary electric blasting caps that should be connected in one series, regardless of whether the work is wet or dry and of the source and amount of firing current available. One explosive company puts this limit at fifty. Where it is necessary to connect longer lines of electric blasting caps in series, nothing but enameled wire caps should be used, no matter how dry the work may be. The surest method of firing electric blasts is to connect all detonators in parallel and to use a power current. I would advise that the parallel method be used whenever possible and that the connections from the firing line be made cross cornered, across the blast to insure an even distribution of the current through all of the electric blasting caps.

"While all electric blasting caps are tested within very close limits for bridge resistance, it is absolutely impossible for all bridge wires to have exactly the same resistance. Consequently some caps are bound to be slightly more sensitive than others. This makes it undesirable to use a firing current that builds up after it centers the blasting circuit. Such a current is likely to cause the more sensitive caps to explode first and destroy the circuit before the less sensitive receive enough current to fire them. This building up of the current passing through the blasting caps is the cause of the failures that so frequently occur when attempts are made to fire more than one shot at a time by means of dry cells or storage batteries. For this reason blasting machines are short circuited until the end of the rack-bar stroke, the current being thus built up to the full intensity before being thrown into the firing circuit. For the same reason there should always be a load on the dynamo that furnishes current for a firing circuit when a blast is about to be shot. This phenomenon of building-up effect in an electrical current also has a bearing on the use of alternating current for firing blasts. The shortest interval of time between the application of the firing current and the explosion of an electric blasting cap is 0.014 seconds. Now in the 25-cycle current, the half cycle is 0.02 seconds, which is a longer period of time than 0.014 seconds. Consequently, there is a possibility that a current of 25-cycles may be thrown into the blasting circuit in such a manner that a building-up effect, similar to that of the dry cell, will take place and will cause a misfire in a series blasting circuit.

"To avoid the possibility of misfires, the crest of the alternation must always pass through a series-connected blasting circuit in 0.014 seconds. As the half cycle of the 50-cycle current is 0.01 seconds and of the 60-cycle current 0.0083 seconds, which are both less than 0.014 seconds, the 50 and 60-cycle alternating currents can be used for firing series circuits with the same assurance as direct current. The 25-cycle current can be used for parallel connections with perfect safety because of the explosion of an electric blasting cap in this type of connection does not instantly destroy the circuit. The handling of misfires is a serious problem. The safest procedure in outside work seems to be always to measure the distance between the top of the charge and the collar of the bore hole and then, if a hole misfires, to remove the tamping to within a few inches of the charge, load a fresh primer and shoot again. The Oliver Mining Company in its mines in the Eleveth district of Minnesota uses a blow-pipe with a brass tip for blowing the tamping out by compressed air. One quarry superintendent in the East always measures the distance in his well drill holes and uses a good loam tamping free from grit. If a hole misfires, he takes a sharp pointed stick of about 1½ inches diameter which he moistens from time to time with water, makes a hole to within a few inches of the top of the charge, loads this with several 1¼x8-inch dynamite cartridges and a fresh primer and fires the charge. So far, this procedure has never failed to pull the missed shot.

"Another common rule for handling misfires is to drill a second hole alongside at a safe distance, this distance depending upon the size of the charge in the missed hole, load the second hole and fire by means of an electric blasting machine. This method, however, is not received with favor by a large number of operators because they are never sure of the first hole or the amount of unexploded powder in the muck. Where a missed hole cannot be reached, the greatest care should be taken in working around it until the powder charge can be located and either fired or removed. It is always best to keep the hole drenched with water while the tamping is being removed.

"Some companies keep a record of all misfires and classify them as to cause. This has sometimes led to the discovery and correction of improper practices when it was found that an unduly large number of misfires were traceable to a single cause."

Slate In 1926

The value of the slate sold at the quarries of the United States in 1926 was $12,030,000, according to estimates furnished by producers to the Bureau of Mines, Department of Commerce. This was 4 per cent less than the value reported for 1925. Slate reported sold for electrical, structural and sanitary, and miscellaneous uses (chiefly flagstones) showed increase in both quantity and value, while the other products decreased.

The roofing slate sold amounted to 455,000 squares, valued at $4,832,000, a decrease of 8 per cent in quantity and 5 per cent in value. There was an increase of 34 cents in the average value per square. The total sales of mill stock amounted to 9,831,000 square feet, valued at $4,084,000, a decrease of 11 per cent in quantity and 3 per cent in value.

Sales of structural slate—2,410,000 square feet, valued at $937,000—increased 3 per cent in quantity and 9 per cent in value. Sales of electrical slate, estimated at 1,872,000 square feet, valued at $1,565,000, increased 13 per cent in quantity and 14 per cent in value.

Sales of mill stock for blackboards which was the only variety of mill product that showed increased sales in 1925 decreased 27 per cent in quantity and 23 per cent in value in 1926. The estimated output was 3,760,000 square feet, valued at $1,298,000. The sales of crushed slate for roofing granules and flour in 1926 was estimated at 495,700 short tons, valued at $3,034,000, which was practically the same quantity as in 1925. The average value per ton was somewhat lower than in 1925.

The accompanying table compares the estimated sales of slate by quarrymen in 1926, by uses, with the sales in 1925.

Ohio Gravel Ballast Company Sells Entire Capital Stock

The Ohio Gravel Ballast Company announces that its entire common capital stock has been purchased by Messrs. Earl Zimmerman, Fred W. Cornuelle and George W. Doran. The company has been reorganized by the election of the following: President, Earl Zimmerman, vice-president and general manager, Fred W. Cornuelle, and treasurer, George W. Doran.

Lime in Slag Cements

Experiment shows that the addition of slaked or unslaked lime to slag cement has a deleterious effect. Small or large amounts of lime whether slaker or unslaked always cause a lowering of the strength as compared with that of the clinker.—R. Grün (Zement, Vol. 15, p. 952-954, 1926).

Use	1925		1926 (Estimated)	
	Quantity	Value b	Quantity	Value b
Roofing .... squares	494,530	$5,084,945	455,000	$4,832,000
Approximate short tons	166,000	....	153,000	....
Electrical .... sq. ft.	1,655,810	1,376,948	1,872,000	1,565,000
Approximate short tons	11,900	....	13,500	....
Structural and sanitary .... sq. ft.	2,332,700	862,019	2,140,000	937,000
Approximate short tons	16,700	....	17,300	....
Grave vaults and covers .... sq. ft.	523,850	125,582	470,000	124,000
Approximate short tons	7,500	....	6,700	....
Blackboards and bulletin boards .... sq. ft.	5,184,060	1,690,612	3,760,000	1,298,000
Approximate short tons	13,900	....	10,000	....
Billiard table tops .... sq. ft.	341,440	140,498	330,000	128,000
Approximate short tons	2,500	....	2,400	....
School slates .... pieces	1,944,320	35,818	1,850,000	32,000
Approximate square feet	1,040,000	....	989,000	....
Approximate short tons	1,400	....	1,300	....
Granules .... short tons	497,700	3,210,904	495,700	3,034,000
Other .... short tons (estimated)	7,000	48,000	10,000	76,000
Total (quantities approximate, in short tons)	724,600	$12,575,326	710,000	$12,026,000

a. In 1925 the mill stock sold, including school slates, was 11,077,860 square feet, valued at $4,231,477; in 1926, 9,831,000 square feet, valued at $4,084,000.
b. F. O. B. at point of shipment.

New Incorporations

Independent Limestone Co., Bedford, Ind., $200,000. Will open quarry on Rockport Road, Vanburen township. Incorporators: Jesse G. Ray, Chicago; Peter M. Norton, Frederick Norton, Bedford. Officers, Jesse G. Ray, Pres.; Henry Struble, Chicago, Vice Pres.; Frederick Norton, Sec'y-Treas.

North Loop Gravel Co., Inc., San Antonio, Tex. $50,000. E. V. Biles, 141 N. Clair St.; James Donaldson, M. L. Roark.

Lavery Granite Co., $25,000. W. H. Reeves, A. E. Monetti. (Filed by L. O. Condit, 55 Wall St., New York City.)

Chipley Lime Products, Inc., Tallahassee, Fla. $40,000. A. R. Richardson, Pres.; W. T. Wallis, Jr.

Ocala-Tampa Lime Rock Co., Tampa, Fla. W. I. Webb, 1926 Bayshore Blvd.

Southern Sand & Gravel Co., Inc. $100,000. (c/o John P. Booth, Attorney, 33 W. 60th St., New York City.)

Huron Gravel Co., 739 Taylor Ave., Detroit, Mich. $250,000. Gravel and stone.

American Gypsum Products Co., Salt Lake City, Utah. $500,000. J. A. Egildson, Pres.; E. J. Miltenberger, Vice Pres.; A. N. Leonard, Sec'y-Treas.; D. P. Thomas, O. A. Egildson.

Becker County Sand & Gravel Co., Brainerd, Minn. $50,000. Mining, washing, reducing, refining sand and gravel; manufacturing cement and cement products. F. E. Murphy, W. B. Cook, Crosby, Minn.; M. W. Richards, Brainerd, Minn.; E. E. Farrell, Duluth, Minn.

Bessemer Limestone & Cement Co., Wilmington, Del. $16,800,000.

Rockbestos Products Corp., 9 S. Clinton St., Chicago, Ill. $91,184. (Mass. corp.)

Huguenot Sand & Gravel Co., Richmond, N. Y. $100,000. P. G. R. Schram, H. A. Conway. (Filed by E. L. Sutton, Stapleton, N. Y.)

Phoenix Products Co., Inc., 402 Broad St., Newark, N. J. Manufacture concrete products. $125,000.

North American Gypsum Co., Inc. $500,000. (Colonial Charter Co., Wilmington, Del.)

Edmondson County Rock Asphalt Co. $250,000. W. P. Flack, S. R. Twyford, Butler, Pa.; James Moorehead, Zelienople, Pa. (Corp. Trust Co. of Dela.)

Chilhowee Stone Co., Charles M. Seymour, Empire Bldg., Knoxville, Tenn. $4,000. Other incorporators, W. C. Anderson, A. L. Mason, C. A. Scheibel, Joseph W. Sullivan, Jr.

Pure Rock Asphalt Co., Louisville, Ky. $1,000,000. Fred G. B. Metzner, Walter P. Fink, J. L. H. Harper, Henry Stephan.

Olympia Concrete Products Co., Olympia, Wash. $20,000. Ray Wood, Fred W. Stockin, Gerry Lemon.

Monmouth Washed Sand & Gravel, Inc., Freehold, N. Y. $100,000. Cement blocks. George E. Fournier, Anna M. Fournier, Armond J. Fournier, Middletown, N. Y. (Attorney, Max Finegold, Freehold, N. Y.)

Southwestern Marble & Tile Co., Little Rock, Ark. 500 shares common, n.p.v.; 200 shares pfd., $100.00 p.v. R. E. Overman, R. E. Overman, Jr., C. H. Lee, Wallace Townsend.

Arnosti Marble Co., Carthage, Mo. $50,000. Texas Agent, Charles E. Coombes, Abilene.

West Paterson Sand & Gravel Co., Paterson, N. J. $100,000. Alex Shapiro, Reuben H. Reiffin, Jeanette M. Petrie, Paterson. (Attorney, Reuben R. Reiffin, Paterson.)

Winchester Sand & Gravel Co., Winchester, Ky. $30,000. Has taken over holdings of Winchester Granite & Brick Co., Dudley, Ky., and extensive improvements have been planned. J. C. Codell, Pres.; R. D. Blanton, Vice Pres.; H. C. McNeill, Sec'y-Treas.

Ottmann Sand & Gravel Corp., Mount Vernon, N. Y. $25,000. F. A. and L. J. Ottmann, C. M. Brobst. (Filed by E. R. Eckley, Mamaroneck)

Star Sand & Gravel Co., Tacoma, Wash. $50,000. N. E. Robbins and S. Harold Shefelman.

Pre-Cast Tile-Marble-Stone Co., W. J. Flynn, N. L. Kalman, E. R. Bayer. $100,000. (Filed by F. A. Muldoon, 3029 Third Ave., New York City.)

Corydon Crushed Stone & Lime Co., Corydon, Ind. $15,000. Quarry and produce crushed stone. Directors, Charles A. Keller, Ed S. Bulleit, Edgar L. Miles, Will J. Bulleit, C. A. Quebbeman.

Independent Limestone Co., Bedford, Ind. $200,000. Will open quarry on Rockport Road, Vanburen township. Incorporators: Jesse G. Ray, Chicago; Peter M. Norton, Frederick Norton, Bedford. Officers: Jesse G. Ray, Pres.; Henry Struble, Chicago, Vice Pres.; Frederick Norton, Secy.-Treas.

North Loop Gravel Co., Inc., San Antonio, Tex. $50,000. E. V. Biles, James Donaldson, M. L. Roark.

Fluck Cutstone Co., Inc., Springfield, Ill. Cutting, quarrying, dealing in stone and all other business allied therewith. $200,000.

Lavery Granite Co., $25,000. W. H. Reeves, A. E. Monetti. (Filed by L. O. Condit, 55 Wall St., New York City.)

The Duzit Screen

The Duzit Agitating Screen Company has published a circular describing the new Duzit Screen. This screen consists of a number of grates placed parallel, connected on both ends to a shaft and centrally balanced on a rocker arm. Alternate grates as 1, 3, 5 and 7 move in up direction while the intervening grates 2, 4, 6 and 8 move in a downward direction. This motion allows all particles of the desired size to catch and pass through the grates' openings to the receptacle.

The screen is constructed without ring gears, cogs or trips which wear and need replacing. Each bearing of the screen is equipped with a grease oiling cup. It is claimed that this screen is non-cloggable because the grates are so constructed to allow all particles to pass through, as they are tapered downward, being smaller at the bottom than at the top. It requires only four feet of head room and the grates can be changed readily and in a short space of time. The screen is constructed to separate all materials such as gravel, sand, crushed rock, etc. It can also be used for washing plants as with two or three sets of grates, one over the other, the water usage is small.

E. C. Sooy Passes

Mr. Ephraim Sooy, President, Kansas City Hay Press Company, died on Saturday, January eighth, Nineteen hundred and twenty-seven.

Mayer and Oswald Open Office In Chicago

James L. Mayer and Frederick E. Oswald announce the opening of a sales office for industrial engineering equipment at 332 So. La Salle St., Chicago, Ill. They are now representing the Dings Magnetic Separator Company, the Saginaw Stamping & Tool Company manufacturers of pressed steel overhead conveyor wheels, trolleys, and casters and the Dixie Machinery Manufacturing Company manufactures of crushers, hammer mills and pulverizers.

Speeder in New Home

The Speeder Machinery Corporation, formerly of Fairfield, Iowa, has moved its factory and general offices to Cedar Rapids, Iowa.

New Lidgerwood Office

The Lidgerwood Manufacturing Company has established an office and warehouse at 401 Barnett Bank Building, Jacksonville, Florida, in charge of Mr. L. C. Hastings.

Traylor Blake Type Crusher

The Traylor Engineering and Manufacturing Company has recently published a catalog describing the Blake Type Jaw Crusher. In general, this crusher may be described as a machine for crushing rock, having a renewable crushing plate, usually corrugated, fixed in a vertical position at the front end of a hollow rectangular frame, inside, and a second similar plate set at a suitable angle with the first plate. The second plate is attached to a swinging lever, called the jaw, which is suspended from a shaft resting in bearings in the sides of the frame, at the top, with means provided for moving this swinging jaw forward and backward, to produce successive blows.

The crushers made by this company have a massively proportioned frame with ample weight and strength for shock absorption, and to withstand the strains incident to crushing and is made in one piece of semi-steel. Cast integral with the frame are the bearings for the swing jaw shaft, those for the eccentric pitman shaft, a flange at the rear end, with a boss on each side underneath for supporting the controlling mechanism of the toggle block adjustment, four lugs at the front, one on the top and one on the bottom of each side, which serve to support and retain the fixed jaw plate, and a bracket at the rear for anchoring the spring tension rod. The swing jaw shaft bearings are cast integral with the frame, and are lined with babbitt to fit the swing jaw shaft. The pitman is made in one piece, of annealed open hearth cast steel. The swing jaw is made of semi-steel of heavy weight and ribbed on the back to secure maximum strength. Jaw plates and check plates are made of chilled Mayari iron or manganese steel, as the service desires. The toggle system is of the four bearing type, with seats in the swing jaw, in both sides of the pitman and in the toggle block at the rear of the machine. These crushers are made in 11 sizes, the smallest with an opening of 7 x 10 inches and the largest with a 24 x 36 inch opening.

I. T. Goodrich Passes

Mr. I. T. Goodrich, general sales manager, The Miami Trailer-Scraper Company died at the Henrotin Hospital, Chicago, Illinois, January 9th, 1927. Mr. Goodrich had gone to Chicago to take charge of the Miami exhibit at the Good Roads Show. On Saturday noon he was taken suddenly ill at the exhibit and was removed to the Hotel for medical attention. On Saturday evening he was removed to the Henrotin Hospital where he was operated on. He rallied from the operation but passed away at 9:30 Sunday evening.

Schramm Air Compressors

Schramm, Incorporated, recently issued a catalog describing the Schramm air compressors. These outfits are built in four sizes, having displacements of 60, 120, 180 and 240 cubic feet of free air per minute. Each outfit is completely housed with removable steel sides and equipped with a heavy riveted tank. The one-piece cast steel frame used on all sizes, except 60 foot, makes these machines rugged, so that the desired alignment of engine and compressor is maintained. The heavy duty type Buda engine and the Schramm compressor are connected by a flexible clutch. This arrangement permits the engine being started without the compressor load.

A slow down governor automatically cuts the engine speeds to a minimum as soon as the air compressor unloads, thereby saving wear and fuel. The machines are also provided with gasoline strainers to prevent dirt or water from entering the carburetor. Where speed of transportation from job to job is a factor, the compressors are mounted on a trailer type truck, equipped with springs and rubber tired wheels, on the 60 and 120 foot sizes the spring mounted trucks can also be equipped with solid steel disc or wooden spoked artillery wheels, both rubber tired. The 180 and 240 foot sizes are furnished with artillery wheels only on the trailer type truck.

The standard radiator equipment on the portable compressor units is of the one section type, selected for its large cooling capacity and because this style eliminates many small joints and packings. However, sectional type radiators can be furnished without extra cost, the entire core section being installed in the same space regularly occupied by the standard core.

The Schramm compressor hoist was designed to meet the demands of the iron and steel trade. However, they are widely used in quarries for rock drilling and hoisting large boulders from the quarry pits. The hoists, which are of the cone friction type, have large machined drums, bronze bushed at each end and with windlass spool in addition. They are controlled by hand lever and equipped with ratchet and pawl, spring released, asbestos lined brake band with foot lever control. Each hoist is back geared, using cut gears, giving smooth operation and the necessary lifting power.

New Arc Welding Machine

Among the many interesting developments in the machinery building field is the substitution of welded structural steel in place of gray iron castings, and one of its applications is a 300 ampere alternating current power supply Lincoln Stable-Arc welder. There are only two gray iron castings, weighing about 15 pounds total, on the outfit which have not been replaced with welded steel construction. Other sizes and types are being changed over to the steel construction as rapidly as possible. The motor and generator end rings, brackets and connecting ring are all made of structural angles rolled up into the proper shape and welded together. The feet of the motor generator set are made of drop forgings. The truck wheels are made of T-sections rolled on a special machine. The hub of the wheel is made of steel tubing. Control panels are usually made of slate or special non-metallic compounds, but the panel on this machine is made of sheet steel welded together and welded to the supports.

The underlying idea in the application of the principles of welded steel construction to the welder was to meet the severe conditions to which portable welding equipment is subjected. Failure in operation of a welding machine is, in many cases, a serious matter. It is claimed that the steel construction, due to the fact that it will bend rather than break, reduces the liability of failure for the reason that the bent parts may be strengthened and the equipment put in operation without waiting for replacement castings. In several cases, the control panel has been crushed with instruments and switches wrecked. However. the equipment was repaired by strengthening the panel and switches and put into operation within an hour without the instruments.

Foster Opens Chicago Office

The L. B. Foster Company has recently opened a Chicago office in the Illinois Merchants Bank Building, 231 La Salle Street. This office will be in charge of R. A. Foster, vice president of the company.

The New Albany Machine Manufacturing Company has purchased from Sullivan Machinery Company all Patents, Drawings, Jigs, Inventory and Sole Rights to manufacture the Sullivan Steam and Electric Channelers and will start manufacturing these machines in the near future.

American Gasoline Shovel

The American Hoist & Derrick Company has developed the American model "K" gasoline shovel, which is illustrated and described in a new booklet issued by the company. The feature of this shovel is its versatility as when it has completed the job for which it was purchased, with the exception of a few minutes needed for adjustments, it can swing to an entirely different type of work. This makes it possible to keep the machine constantly at work going from one job to an entirely different class of operation. The fact that this shovel can become an efficient performer as a dragline excavator, pile driver, gen, eral purpose crane, shovel or log loader, with only the lapse of time necessary to change the boom, makes it a machine of which all around use insures a steady income.

The machine is mounted on continuous chain treads, which is the applied name for the crawler type of traveling mechanism, and is able to penetrate the roughest country. It can climb hills and travel over rough and uneven ground with apparent ease, while the broad steel tread frames make it possible to crawl over the soft spots. Due to this ruggedness of construction, the shovel is able to keep on the job in rough country where a breakdown would mean several days delay. The traveling mechanism is sufficiently narrow to conform to railway shipping clearances. This makes it possible to ship the machine on a flat car without dismantling.

New Milburn Cutting Torch

The cutting of heavy plates, risers, gates, billets, etc. with ordinary 4 inch water column pressure, ounces pressure or pounds pressure using either city gas, natural gas or by-product (coke oven) gas has been made possible by the development of the Milburn oxy-illuminating gas cutting torch, type LPG, which is manufactured by The Alexander Milburn Company. An interesting achievement of this torch is that it can be used with by-product (coke oven) gas. It is not necessary to have this gas scrubbed; it can be used just as it comes from the coke ovens.

In tests made the cuts showed a sharp clean edge, devoid of slag on the underside of the cut, a narrow kerf and very smooth surfaces. A very important feature is the noncase hardening of the surfaces, which makes for easier machining, being able to maintain the same speeds and feeds while performing the machining operations. The torch is made of bronze forgings and special seamless tubing, constructed to withstand constant and severe service. It is evenly balanced and ruggedly built. The high pressure cutting oxygen is controlled by a thumb valve which remains fixed in either open or closed position. The torch is supplied with a range of tips to accommodate all thicknesses of metal. The tips are made of solid copper, designed to rapidly preheat the gasses, giving better penetration and quicker cutting.

Combustion Engineering in New Building

With the recent formal occupancy of its new building, International Combustion Engineering Corporation has added one more of the large industrial corporations in the last few years to the trend uptown. International Combustion Building located on Madison Avenue between 35th and 36th Streets is the sixth largest office building in the country and because of its location at the crest of Murray Hill stands forth on the sky-line of New York as one of the most outstanding recent additions to the city's growth.

A part of the space in International Combustion Building will be used by the company in completing the design and engineering detail of its first large orders for apparatus for the distillation of coal at low temperatures, developed by Dr. Runge and Samuel McEwen, and known as the McEwen-Runge process. A half floor in the building in addition to this has been turned over to a department under the direction of Dr. Wm. L. DeBaufre, one of the most prominent scientists in the country, for perfecting an entirely new phase of power plant development which combines the use of pulverized coal and low temperature distillation.

International Combustion Engineering Corporation has shown remarkable growth since its organization in 1920. Its first offices consisted of one half floor of approximately 7,000 square feet in the Bowling Green Building at 11 Broadway. The rapid growth of the organization made it necessary in 1921 to build and occupy its own building consisting of eight stories and known as the Combustion Engineering Building at 43 Broad Street, where it occupied five floors or a total area of 30,000 square feet. In less than three years the continuous growth made it necessary to hire floors in other buildings and with this formal occupancy of the International Combustion Building it expands its space to 80,000 square feet with arrangements for additional space at later dates as its forecasted requirements develop the need for it.

Du Pont Holds Convention

One of the most important technical conventions ever held by the explosives department of E. E. du Pont de Nemours & Company took place at the main office of the company in Wilmington, Delaware, January 25, 26 and 27 this year. The complete explosives technical force of the main office and the field was in attendance. Officials of the company, of the explosives department, of the chemical, manufacturing, and sales forces were also in attendance. This convention was attended by a representative of Nobel industries, Ltd., of England, and by representatives of the Canadian Explosives, Ltd., of Montrial, and the Canadian Giant, Ltd., of Vancouver, Canada. Reports from all coal and other mining fields where pellet powder is being used were made to the convention. This powder, which is a new explosive placed on the market by the du Pont Company, is regarded as a great step forward in safety and economy. Its use is increasing everywhere it is suitable to employ it. Reports on the new permissible explosive of the company were also heard. Practically every phase of coal mining having to do with explosives and the problems which arise both here and abroad were discussed. The convention was so arranged that papers touching on various subjects were first read and then subjects listed for discussion were taken up. It resulted in a great amount of ground being covered in a thorough manner. One of the big questions brought up was that of misfires. This received the attention of all the technical men present and the discussion was participated in by men from all mining fields in the United States. The practices in England on this subject and in Canada were also brought to the attention of the convention. Arthur La Motte, Manager of the Technical Section of the Explosives Department, presided.

New Mundy Appointments

The Mundy Sales Corporation announces the following appointments of new distributors: W. H. Anderson Tool & Supply Company, Grand Rapids, Michigan, exclusive distributors on Mundy Hoisting Equipment for western Michigan; Mr. Cyril J. Burke, Detroit, Michigan, will handle all of eastern Michigan with exception of Lenawee and Monroe Counties; Cunningham-Ortmayer Company, Milwaukee, Wisconsin; exclusive distributors for the State of Wisconsin; Mr. R. W. Simpson, Cedar Rapids, Iowa, exclusive distributor for the Mundy line in Iowa.

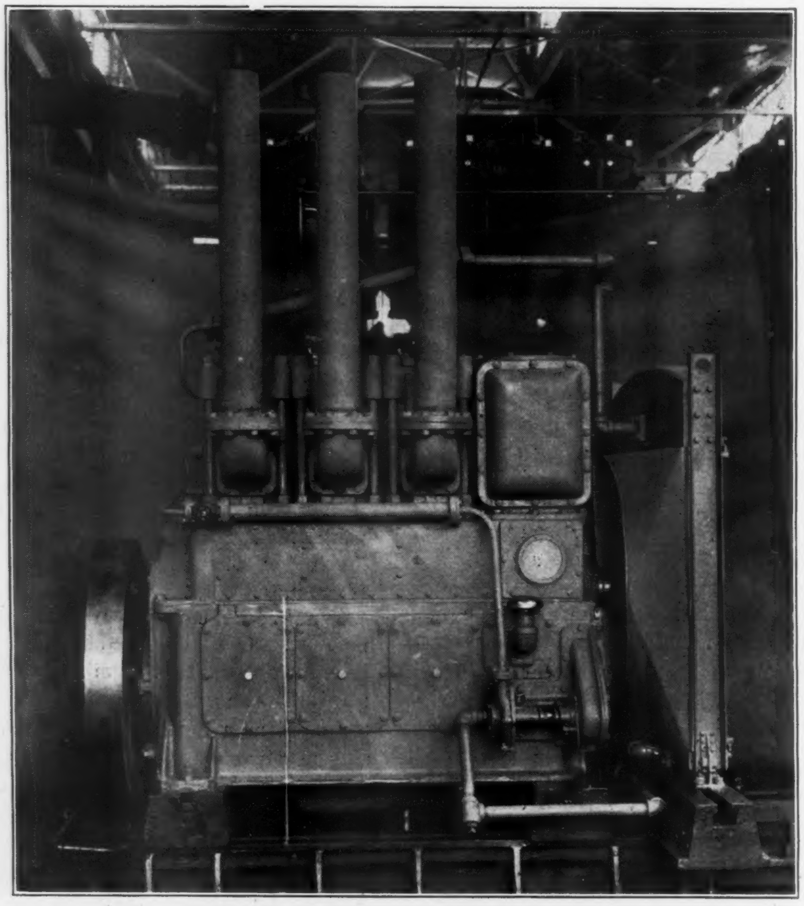
New Worthington Engine

The Worthington Pump and Machinery Company has recently developed a Diesel Engine which is intended to be used for portable service. Portable power units are called upon to withstand far more service of operation than almost any other service. Such plants usually operate in places where dust and dirt are prevelant. It is, therefore, essential that engines for this service be so completely enclosed that dust or dirt cannot get into the working parts.

An engine intended for portable service must of necessity operate at speeds somewhat higher than those speeds encountered in the more common Diesel engine plants, and yet at the same time a long life is essential. Again, in portable service of any kind an engine is frequently required to operate or idle at very slow speeds. Another requirement for engines used for this service is the necessity of providing some means of recooling the water used for cooling the engine.

The Worthington Diesel engine manufactured to meet these requirements is a vertical, two cycle, solid injection type. It is an improved and simplified design of high compression engine, free from hot bulbs or hot plates for ignition, obtaining such ignition solely from the heat of compression, and controlling the combustion by a special form of combustion chamber, completely water jacketed.

The engine is of the trunk piston type, and the scavenging air is pumped to the power cylinders by an independent scavenging cylinder. The scavenging air, consequently, does not pass through the crank case, by which means the excessive waste of lubricating oil in crank case compression engines is avoided. On the scavenging cylinder, Worthington feather valves are used for both suction and discharge. The engine frame and base form one compact, substantial and accessible piece. Access to the main bearing and crank pins is secured through large doors bolted to the frame casting.



New Worthington Portable Diesel Engine

The cylinders are cast separately, each with its own water jacket, and are secured to the entablature casting by long tie bars or tension members. These tension members extend upward through the cylinder head so that both cylinder and cylinder head are held to the entablature by upper nuts upon the upper end of the tension members. The force feed system of lubrication is used for all bearings. The lubricating oil is drawn from the crank pit and forced by a mechanically operated pump to main bearings, crank pin and wrist pin, returning to a sump below the crank pit, whence it is drawn through an easily cleaned strainer into the lubricating oil pump. Cylinder and pistons are lubricated from the oil spray thrown off by the main running gear of the engine.

Fuel oil is pumped from a constant level suction tank directly into the combustion chamber, through a special spray valve by a direct acting pump. Both pump and driving gear are so designed as to give proper atomization without the use of compressed air for injection purposes. The amount of fuel oil required at different loads is regulated by the governor, which, by rocking a shaft, regulates the time of opening of the injection pump bypass.

For the purpose of recooling the water used for cooling the engine a radiator can be mounted on the carriage, and provision made at the forward end of the engine for driving a fan. The fan is driven by means of a silent chain. Friction discs are provided to allow slippage, as a protection in connection with the fan. This same chain drives a centrifugal pump located at the side of the engine and is of ample capacity to keep the engine cool.

Kent Transmission Machinery

The Kent Machine Company has issued a catalog illustrating the power transmission machinery which this company manufacturers. This book describes the following elements used for power transmitting: shafting; couplings; collars; friction clutches; pulleys sheaves bearings and belt tighteners. Each of these detail sections describes very completely the various types of the particular element by means of text and illustrations. A detailed drawing is also given of the part with accompaning tables so that the person interested can ascertain dimensions of the element such as over-all, diameters, length, width, etc., in order to comply with the proper application of the unit.

Several pages of engineering data are given in the catalog which are useful to the industry. The set of rules for determining house power and width of leather belts, another giving the rules for determining horse power, width, plies, and length of rubber belts and also the rules for determining diameters and speed of rope sheaves, pulley or gears are well worth noting. The catalog is so well amplified with text, illustrations and tables that it should be useful to the designer, purchasing agent, superintendent or anyone interested in the correct application of power transmission machinery.

The General Excavator

The General Excavator Company has recently issued bulletin 2701 describing the General Excavator. It is claimed that this excavator is not an experiment as it represents more than twenty years' experience in the designing and manufacturing of similar equipment. It has been designed for service as a shovel, crane, dragline, ditcher, trencher, skimmer or backfiller. It is fitted with rugged, well balanced, flexible and mobile operating machinery combined within a compact unit. The conversion to any one of the services specified is simply a matter of changing booms, accessories and wire ropes. These changes can be effected in the field in a short time, no additions or changes being necessary to the operating machinery. Every boom is interchangeable with every other boom.

The same lugs on the front end of the cast steel center member or bed are used for the boom foot on shovel, crane, dragline, ditcher, trencher, skimmer and back-filler. The excavator is designed to operate with gasoline engine or electric motor.

The excavator is full revolving and is mounted upon continuous treads. In action it swings and travels rapidly which means quick handling and large output. The power unit used, gasoline engine or electric motor, is of ample power to insure a generous reserve for emergencies. It is a rugged, flexible, half cubic yard machine. The material used in its construction is selected for its fitness in the service where it will be employed. The various parts are inspected both before and after machining. During assembly the pieces are checked and fitting is carefully supervised. When the machine is completed, it is subjected to a series of tests, and when it leaves the factory it is ready for service. This machine is standardized, only one size and type being built at this plant.

Some details of its construction are of interest. The foundation for the entire upper body is a single steel casting which weighs more than a ton. Upon this casting all the operating machinery is secured. It also carries the large conical revolving rollers. Cast integral with this center member are the lugs to which all booms are hinged. The power plant, when gasoline is used, is a heavy duty 4 cylinder Buda YTU of 4½ inch bore and 6 inch stroke. It runs at the speed of 1,000 r. p. m. and delivers 45 horse power and is capable of delivering from 30 to 40 per cent greater power. The main drive between power plant and operating machinery is through a silent chain. The drums are double independent on the same shaft and are used for seven different operating combinations. The clutches for digging, hoisting, swinging and traveling are four in number and of the outside contracting band type. The controls consist of levers and pedals controlling every operation of the machine. They are centralized and are within reach of the operator without moving from his seat. Four levers and two pedals are all that are necessary for all ordinary operations of the machine. Two of these levers control the reversing clutches, the third handles the pull-back drum clutch and the fourth handles the hoisting drum clutch. The pedals control the hoisting drum brake and pull-back drum brake. The weight of the excavator is approximately 32,000 pounds and when shipping, with the boom lowered, the machine is 10 feet 8 inches over all in height, which gives ample clearance for all bridges and tunnels on all lines.

Williamsport Wire Rope Reorganizes

With the purchase of the Cochran interests by a syndicate headed by Robert Gilmore, Edgar Munson, Logan Cunningham and C. M. Ballard, the control of the industry of the Williamsport Wire Rope Company virtually passes into the hands of old employees, who put into immediate action, the building of what is expected to be the biggest wire rope plant in America. The new organization while introducing new capital will not effect the personnel of the old organization who have manufactured and distributed the Telfax marked wire rope.

Mr. Robert Gilmore, president, continues as the directing head of having been actively associated with the Company for 34 years. Mr. Edgar Munson becomes vice president and treasurer. Mr. Logan Cunningham becomes vice president and secretary and Mr. C. M. Ballard, vice president and general sales manager.

No time is being lost by the new organization to put into effect one of the most progressive programs of their career, for the task of enlarging their present plant are the extension of present facilities has already begun. During the past six months the work of filling in the area known as the "White Basin" and located to the southwest of the present buildings of the Company has been under way. Plans for new structures are being drafted and the actual construction work will be started just as soon as the fill of the White Basin is completed. The new building will be 450 by 200 feet and will be equipped with the most modern of labor saving devices.

Hunter Machinery Enlarges

The Hunter Machinery Company have completed plans to expand and open new quarters at Grand Rapids. In the fall a contract was awarded for a new office, warehouse, and shop building in Grand Rapids at 530-532 Monroe Ave. N. W. The new building is now completed and all details arranged, organization employed and the company will be ready and open for business on the 2nd day of January 1927.

The territory covered in Michigan will be from the shore of Lake Michigan to the eastern border of Bay, Saginaw, Genesse, Livingston, Jackson and Hillsdale counties. Practically every line that the Hunter Machinery Company represents in Wisconsin will be covered by the new corporation. This includes the Aeroil Burner Company, Atlas Engineering Co., Barnes Mfg. Company, Blaw-Knox Company, Carbic Mfg. Co., Chain Belt Co., Clyde Iron Works, Cleveland Wheelbarrwo Company, Le Roi Company, A. Leschen & Son Rope Co., Parsons Company, Northwest Engineering Co., Sasgen Derrick Company, Sullivan Machinery Co., etc. A complete stock including approximately four carloads of machinery and equipment will be on hand for the service of the Michigan trade as well as a complete parts service stock.

The capital of the Wisconsin Company has also been increased to $100,000.00. Geo A. Cooper and B. E. Uebelle have been made directors in the Wisconsin Company. Andrew Crowley, formerly with the Sullivan Machinery Company, has joined the Wisconsin organization and will take over the territory formerly handled by Mr. T. G. Abrams. Alvin H. Jensen and Ray A. Arndt of Milwaukee have been added to the sales force of the Wisconsin Corporation.

New Botfield Distributors

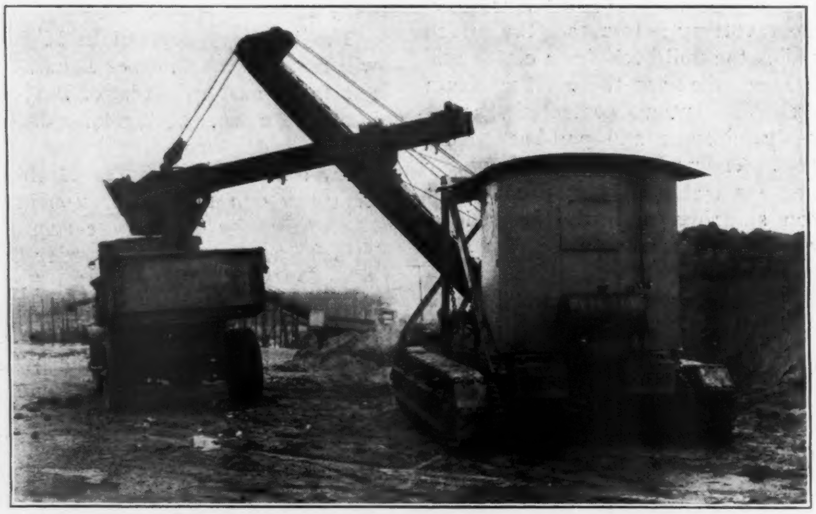
The Botfield Refractories Company have appointed the following concerns as distributors for Adamant Fire Brick Cement: Southern Steel and Cement Company, Asheville, North Carolina, Henry A. Petter Supply Company, Paducah, Kentucky, Columbia Supply Company, 823 West Gervais Street, Columbia, South Carolina, and the Spartanburg Mill Supply Company, 218 Ezell Street, Spartanburg, South Carolina.

New Koppel Bulletin

The Koppel Industrial Car and Equipment Company has completed a new bulletin on quarry cars, track and track equipment which was distributed for the first time at the National Crushed Stone Convention in Detroit, January 17.

New Bear Cat Shovel

The Byers Bear Cat Shovel, first shown publicly at the Chicago Road Show and designated as model 27-R, has been designed to meet the demand for a shovel that will do practically all of the work required of a machine of this type, its only limitation being that work which cannot be done by anything less than a full revolving machine.



New Byers Bear Cat Shovel

The length of boom, dipper stick and size of bucket follows standard practice for machines of this type. The boom is of steel and is of the box girder type construction and is well designed, being heavy enough to get good crowding power and still not heavy enough to cause unstability of the machine. The dipper stick is of the double type, working in a double saddle block outside of the boom, and is made of seasoned oak timber completely armored with steel plates. The boom foot and the hinge casting at the end of the dipper stick are of steel.

The rope crowd is accomplished by means of a drum actuated by a clutch at each end, each of which operates the drum in the opposite direction. The two clutches are operated by one lever and the operation is standard with three levers and one foot brake. An extra brake is provided to assist in holding the dipper stick in any position as well as for the back drum when some other attachment is used.

The crowding line starts at one end on the dipper stick, then around a sheave on the shipper shaft and thence to the back drum by way of a sheave on the boom foot pin and the step sheave; this cable is then wrapped around the other end of the drum and continued over a special top sheave, and down around another sheave on the shipper shaft and is anchored to the other end of the dipper stick by a turn buckle which gives a means of taking up stretch in this cable.

This crowd is extremely sensitive, easily operated and is very fast. It is absolutely positive in action, not depending on any other factor in the operation of the machine and is an independent operation capable of being operated by itself alone.

The bucket is of good design and of a shape that will fill. It has a capacity of 85 percent of a half yard struck measure so that it will easily hold a half yard when heaped. The standard Bear Cat attachments consisting of skimmer, ditcher, clamshell, and backfiller all fit the 27-R shovel without change and without the removal of any part of the mechanism.

Raymond Pulverizers

Raymond automatic pulverizers are made by the Raymond Brothers Impact Pulverizer Company who have recently issued Catalog Number 19 describing the application of this equipment. This company has been manufacturing grinding, pulverizing, and air separating machinery for the reduction of materials to a powdered form since 1887. These pulverizers with air separators are being used for grinding a variety of products. They are applicable where a fine powder is required where a uniform is necessary; where the raw material is of a damp or stick nature; where a dustless grinding operation is desired, or where the material handled is poisonous in its nature.

These pulverizers are built especially for fine pulverizing, and designed for use in connection with air separation. By the use of the Raymond vacuum air separator, fineness of the finished product is at all times under the control of the operator. Once adjusted, the system will deliver a uniform product as long as desired without further attention.

A unique feature, which can be applied to most Raymond pulverizers, eliminates the human element with regard to maintaining capacity and uniform fineness of finished product, is the pneumatic feed control. This control operates entirely by the change in vacuum in the machine, which in turn changes as the amount of material fed varies, and a maximum capacity is produced regardless of the attention or inattention of the operator. The complete Raymond system consists of a pulverizer, an air separator, an exhaust fan, a cyclone collector, a tubular dust collector which is optional, and the necessary connecting pipes of blue annealed steel.

The catalog illustrates installations of automatic pulverizers with air separation, number 00 pulverizers, number 000 pulverizers, number 0000 pulverizers and a vacuum air separating plant. Each of these installations are described by illustrations and text, the reading matter noting with what materials each type of equipment can be used to the best advantage.

Speeder Moves Business

In January, this year, the Speeder Machinery Corporation moved its factory and general offices from Fairfield, Iowa to Cedar Rapids, Iowa. Speeder Cranes and Shovels are now being built in the new plant, which is a modern-equipped shop, with a present capacity of one complete speeder a day. This capacity may be easily increased, as the plant is located on a plot of eight acres.

The new factory is of brick and steel construction of the saw-tooth type, with a forty-foot craneway over the assembly floor. The entire shop is served by an overhead industrial carrier system. The shop and offices are heated by automatic oil-burning superheaters, made by the P. M. Lattner Company, also of Cedar Rapids. The heated air is circulated by a fan system.

Annual Southwest Road Show

The second Annual Southwest Road Show and School will be held in Wichita, Kansas, February 22nd, through the 25th, this year. This road show covers nine states and the present forecast indicates that it will be even more interesting and better attended than the first annual show. Reduced rates have been granted on all the railroads in the Southwest to those desirous of attending the show.

The Insley Excavator

The Insley Manufacturing Company has recently issued Catalog Number 51 describing the Insley Excavator. This excavator is furnished with six interchangeable attachments, shovel, ditcher, skimmer scoop, crane, dragline, backfiller and magnet. The working capacities of the shovel dipper and that of the ditcher, skimmer and dragline are a half-cubic yard. The crane has a capacity of 3,500 pounds at an 18 foot radius, or a half yard clamshell loaded. All attachments of the excavator have an arc of swing of 210 degrees.

Some of the construction features of this machine are as follows. The main frame is built of structural steel, the principal members being made of 10 inch channels all connected with heavy gusset plates throughout. Underneath, running crosswise, two H section beams are used for axles, and these beams and the main members are connected together with a heavily constructed cross bracing. The A frame consists of two heavy front angles mounted on the main frame just behind the bullwheel, which angles lean forward so as to bring the center of the upper pintle over the center of the bullwheel. The two rear supporting angles reach back to the main frame to a point where even distribution of the topping line stresses is obtained. The connections between the main frame and the A frame are through pins in double shear.

The bullwheel is 60 inches in diameter and is made of channels rigidly braced and reinforced on the top and bottom by plates. It is riveted to the bullwheel hub casting, which turns on the pintle casting in swinging, and on this hub casting are provided ears to which the boom is attached. The two hoisting drums are provided with clutches, brakes and ratchet pawls. They are 10 inches in diameter without lagging and 5¾ inches between flanges. With all attachments except the crane, lagging blocks are used to increase the drum diameter to 12¾ inches, and with shovel attachments the front drum is lagged to a diameter of 16¾ inches. The power plant, when gasoline operated, is a Buda 35 horse power heavy duty KTU 4x5¼ inch engine, fitted with a full pressure feed oiling system. The transmission has two forward speeds and one reverse, all digging operations being done with the transmission in low speed. Low gear is also used for short moves and traveling under difficult conditions, and high gear is used in moving from one job to another over improved streets and roads. The excavator can be equipped with an electric motor instead of the Buda engine in cases when material is to be handled inside of a building, and where fire hazards do not permit the operation of a gasoline engine.

The crawlers are made with shoes 13 inches wide, 10 inches pitch length and of high carbon cast steel. Seven double wheel chilled cast truck rollers carry the load, and are mounted in large babbitt bearings. These rollers travel on a track of steel angles, which are bolted on the outside edges of each crawler shoe, and provide an easily renewable wearing surface for the protection of the shoes. The crawlers are driven from the rear, each side being driven by short crawler drive chains leading upward at a steep angle out of the mud. The rear crawler sprockets, which are drivers, have notches which engage teeth on the crawler shoes and thus drive the truck.

Westinghouse Engineer Reorganized

A complete reorganization of the engineering department, to obtain a better concentration of engineering personnel and facilities at the East Springfield Works of the Westinghouse Electric and Manufacturing Company has been announced by Mr. W. S. Rugg, vice president in charge of engineering.

Mr. C. H. Garcelon, formerly manager of the small motor engineering of the East Pittsburgh works has been appointed manager of engineering of the East Springfield works. As manager, he will have adminstrative charge of all engineering at this plant. Mr. C. A. M. Weber has been appointed manager of the small motor engineering department, East Springfield works. M. E. Denman has been made section head in charge of the fan motor section of the small motor engineering department. Mr. A. K. Phillippi will continue to act as resident engineer of the radio engineering department. In the new plan of operation all fan motor and small motor engineering except that of farm lighter and locomotive headlighter work will be located at he East Springfield works. The farm ligher and locomotive headlighter work will be retained at the East Pittsburgh Works under Mr. J. M. Hipple, present manager of motor engineering.

Announcement is also made by Mr. C. E. Allen, district manager, St. Louis office of the Westinghouse Company that Mr. Graeme Ross, has been appointed industrial division manager, St. Louis office; Mr. B. W. Stemmerich, transportation division manager, St. Louis office and Mr. J. J. Thomason, Central Station division manager, St. Louis office.

A. W. Burchard Passes

Anson Wood Burchard, vice chairman of the board of directors and chairman of the executive committee of the General Electric Company and chairman of the board of directors of the International General Electric Company, died Saturday afternoon, January 22, of acute indigestion at the home of Mortimer L. Schiff, with whom he was lunching, in New York City. Funeral services were held Tuesday morning from his late home, 690 Park Avenue, New York, and were in charge of Dr. Robert Norwood, rector of St. Bartholomew's Church. Burial was at Locust Valley, L. I.

Mr. Burchard was born in Hoosick Falls, N. Y., on April 21, 1865. He was graduated from Stevens Institute of Technology in 1885 with the degree of mechanical engineer. In 1902 he joined the organization of the General Electric Company and until 1904 was comptroller, with headquarters at Schenectady. In 1904 he was named assistant to the president, in 1912 he was elected as vice president, and in 1917 was elected a member of the board of directors. In May, 1922, he was elected vice chairman of the board, and in June of the same year he was elected president and chairman of the board of directors of the International General Electric Company. About a year ago he was relieved of the duties of president, but continued as chairman of the board. He was director of several utility and electrical companies, and a member of many electrical and power clubs and organizations.

New Harnischfeger Office

The Harnischfeger Corporation, successor to Pawling & Harnischfeger Company, announces the removal of its branch office at Jacksonville, Florida, from the Peninsular Casualty Bldg. to 509 East 8th Street, Mr. F. W. Truex is branch manager in charge.

After March 1st, the Jacksonville branch warehouse will also be moved. from its present location, 1465 Kings Road to 509 East 8th Street. This combining of office and warehouse will make possible the affording of better service to users of P. & H. equipment.

New Dings Magnetic Offices

The Dings Magnetic Separator Company has established an office at Boston in charge of Mr. George H. Walsh. The new office is located at 304 Rice Building. J. L. Mayer and F. E. Oswald recently opened the Chicago office at 332 So. La. Salle Street.

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Qu.	H.P.		Speed
1	40	Westinghouse, type HF, 220 v., slip-ring	860
1	40	Westinghouse, type CX., 220 v.	850
2	40	G. E., form M., 440 v., slip-ring, with drum starter and resistance for constant speed	720
1	40	Westinghouse, type CX, 440 v.	580
1	40	Allis-Chalmers, type AN, 440 v.	575
1	40	G. E., form K, 220 v.	450
1	50	Wagner, type BP, 220 v.	1200
1	50	Fairbanks-Morse, type H, 220 v.	1200
1	50	Ideal, 220 v.	1160
1	50	Lincoln, type SM, 2200 v., slip-ring	900
1	50	Westinghouse, type CW, 2300 v., slip-ring	870
1	50	Allis-Chalmers, type AN, 440 v.	850
1	50	G. E., form K, 220 v.	720
1	50	G. E., form K, 440 v.	720
3	50	Allis-Chalmers, type AN, 440 v.	575
2	60	G. E., form K, 440 v. (acid proof)	900
1	60	G. E., type MT, 440 v., slip-ring	720
2	60	G. E., form K, 440 v.	600
7	75	G. E., form K, 440 v.	1800
7	75	Allis-Chalmers, type ANY, 220 v., slip-ring, constant speed	1750
1	75	Westinghouse, type CS, 220 or 440 v., direct-coupled to Sturtevant No. 9, horizontal discharge, centrifugal pressure blower	1750
1	75	G. E., type ATI, 220 or 440 v., revolving field, synchronous motor	1200
1	75	Fairbanks-Morse, type BV, 220 v., slip-ring	900
1	75	Westinghouse, CX, 440 v.	850
1	100	G. E. form K, 220 v.	900
1	100	Crocker-Wheeler, 440 v.	865
1	125	Westghse., type CW, 2200 v., sl-rg.	875
1	150	Allis-Chalmers, type ANY, sl.-rg., 440 v.	865
1	150	Electric-Machinery, revolving field, 2200 v., synchronous	900
2	150	Fairbanks-M., type BV, slip-ring	600
1	200	G. E., form K, 2300 v.	900
1	200	G. E., form M, 4000 v. 2300 v., slip-ring	600

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One new 42"x16".
One 8"x5", two 16"x10", two 24"x12", one 30"x10".
Two 26"x15", one 30"x16", two 36"x16", one 54"x24".

CRUSHERS

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One No. 3 Gates—One No. 4 Gates—Two No. 5 Gates.
Two No. 6 Gates & McCully—Two No. 7½ Gates & Austin.
Three No. 8 Gates & Traylor—One No. 9 Gates—One No. 12 Gates.

Jaw

Two 7"x10"—one 6"x20"—two 9"x15"—one 10"x20"—two 12"x24"—one 13"x 30"—one 18"x36"—one 24"x36"—one 48"x60".

Rotary

Two No. 0, two No. 1, one No. 1½, and one No. 2 Sturtevant Rotary Fine Crushers.

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Two—No. 0, two—No. 1 and one No. 2 Duplex Sturtevant ring roll mills.

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3', 4', 4½', 5', 5½', 6', 8' Hardinge Mills and Tube Mills.

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Two 3'x20', Three 4'x30', One 4½'x30', One 5'x40', Three 5½'x40', Two 6'x60', One 7'x60' and One 8'x80' Direct Heat Rotary Dryers. One 5'x25', one 6'x30'. Two 8'x80' Ruggles Coles type "A" and One 4'x20' Ruggles Coles type "B" Double Shell Rotary Dryers.

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4'x40', 6'x60', 6'x90', 6'x100', 6'x120', 7'x80', 8'x125'.

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Air separators, Screens, Elevators and Conveyors.

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1—75-ton, 6 wheel, saddle tank.
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1—60"x20' All manganese stone screen.

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1—30"x36" Kennedy.

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1—No. 1 Sturtevant Ring Roll Mill.
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3—12-ton, 36" gauge, VULCAN, GASOLINE, new 1926.

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1—14x22, std. gauge, AMERICAN, 40-ton Saddle Tank, Steam, new 1920.

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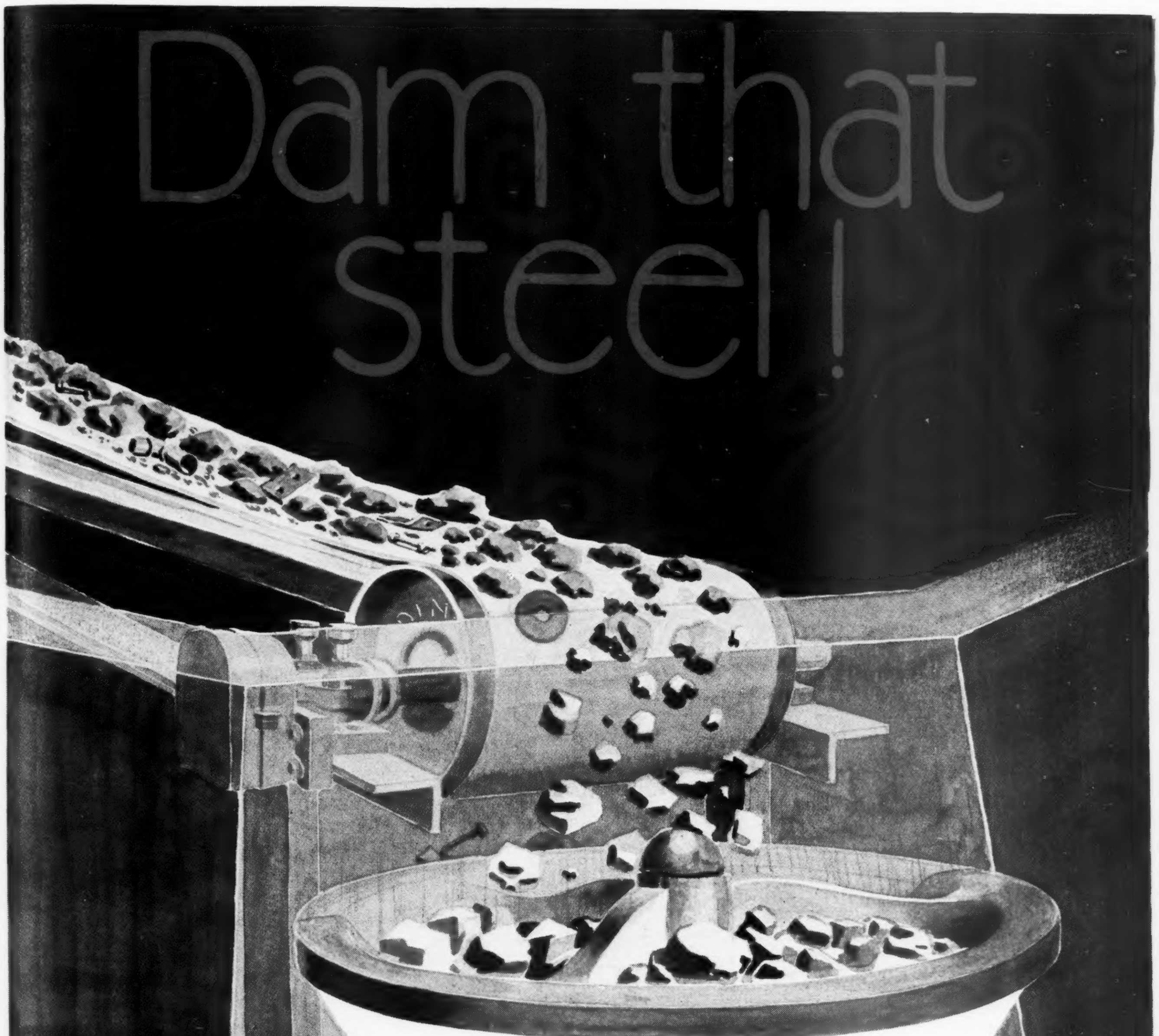
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